Aſtronomical Dialogues

BETWEEN A
GENTLEMAN and a LADY.
WHEREIN THE
DOCTRINE of the SPHERE,
USES of the GLOBES,
AND THE
ELEMENTS
OF
ASTRONOMY and GEOGRAPHY
Are EXPLAINED,
IN A
PLEASANT, EASY, and FAMILIAR WAY.
WITH A
DESCRIPTION of the famous INSTRUMENT
CALLED THE
ORRERY.

K

By JOHN HARRIS, D.D. and F.R.S.

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Corrected by GEORGE GORDON.

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MDCCLXVI.

BRITISH MUSEUM

TO THE

Lady *CAIRNES.*

MADAM,

AS the Deſign of theſe DIALOGUES carries them naturally into the Patronage of the Fair Sex; ſo your own Merit, and my Duty, determine them to your Ladyſhip.

To you, Madam! who are bleſt with all thoſe natural Graces and Genteel Accompliſhments,

ments, which juſtly command univerſal Eſteem; while Perſons of true Taſte and thorough Knowledge of Life, with Pleaſure ſee even *thoſe* exceeded by intellectual Beauties, and ſuch as claim Addreſſes of this Nature. For what can be more engaging, than to find at Lady CAIRNES's Table, the greateſt Liberality and Elegance of Entertainment, outdone by improving Converſation, and the Underſtanding more regaled than the Senſes?

But I know I muſt forbear; and not offend ſuch a Modeſty as your's even with Truth: However, I cannot help ſhewing that I am neither inſenſible of what all the World admires, nor ungrateful for the Obligations you have ſo generouſly conferred on,

MADAM,

Your LADYSHIP'S

Moſt Humble Servant,

J. HARRIS.

THE

PREFACE.

THIS Book was moſt of it written a good while ago: And being ſuppoſed to be loſt for ſome Years, was lately retrieved, and reviewed by it's Author, with the Diſintereſtedneſs of a Stranger. However, I liked it ſo well, as to reſolve upon it's preſent Publication, with ſome few Emendations and Additions. Of which latter ſort the Deſcription of the famous ORRERY of Mr. *Rowley*, is the moſt conſiderable.

I wrote it in this diverting way, in purſuit of a *Deſign,* which, as I have made the general Buſineſs of my Life, ſo I can look back upon it's Succeſs with Pleaſure, *viz. The engaging Perſons of Birth and Fortune in a warm Application to real and uſeful Learning:* To induce them to detach ſome of their happy Leiſure from being loſt by Sports, Play, or worſe Avocations, and to dedicate it to the Improvement of their Minds.

For I have often been aſhamed and ſhocked to ſee, how aukwardly the few Modeſt have looked, in Converſations where they could bear no Part; and how inſolently others have deſpiſed what they neglected to underſtand.

But what glorious Improvements might one expect from Perſons of Fortune and Leiſure, if they would addict themſelves to theſe Things? who can bear the Expenſe of good Inſtruments for Celeſtial Obſervations.

For though there can hardly be above a Score in an Age, who have purſued theſe Studies thoroughly; yet ſuch *great Lengths* have been run in ſpite of all Diſadvantages, as may eaſily convince us, what to have hoped for, if *great Men* would now and then divert themſelves this way.

The Reader will eaſily ſee that the Converſation in theſe DIALOGUES is *feigned*, and in Imitation of *thoſe* of the excellent Mr. *Fontenelle*, *On the Plurality of Worlds*. And that the *Digreſſions*, *Reflexions*, *Poetry*, and *Turns of Wit*, are introduced to render *thoſe Notions* pleaſing and agreeable, which perhaps without ſuch a kind of Dreſs, would appear too crabbed and abſtracted.

However, I do not perplex my *fair Aſtronomer* with any thing but the *true Syſtem of the World:* I miſlead her by no Notions of *Cryſtalline Heavens*, or *Solid Orbs:* I embarraſs her with no clumſy *Epicycles* or imaginary and indeed impoſſible *Vortices:* But I ſhew her at firſt the Celeſtial World juſt as it is; and teach her no *Hypotheſes*, which, like ſome other things taught at Places of great Name, muſt be *unlearned* again, before we can gain *True Science.*

And as I think it practicable to explain and teach *any Science* in this *facetious way, (Facetè enim & commodè dicere quid vetat?)* ſo perhaps I may hereafter, if God grant me Health, Eaſe, and Leiſure, make ſome other Attempts of this Kind. For the Lady may well be ſuppoſed, though the ſight of the Globes firſt ſtruck her Fancy, and turned her Deſires this way, to have made Excurſions into *other Parts* *of Mathematics*, and to have diſcourſed with her Friend on thoſe Subjects. And perhaps all *thoſe Dialogues* may not be loſt, as *theſe* had like to have been; but may, if theſe find a ſuitable Encouragement, be communicated alſo to the World.

Multaque prætera tibi poſſum commemorando,
Argumenta, fidem dictis conradere noſtris:
Verum animo ſatis hæc Veſtigia parva ſagaci
Sunt; per quæ poſſis cognoſcere cætera tute.

LUCRET. Lib. I.

Aſtronomical

Aſtronomical Dialogues

BETWEEN A

GENTLEMAN and a LADY.

IT is now about ſeven Years ago, ſince I preſented the moſt engaging Lady *M*—— with Mr. *Fontenelle*'s Book of the Plurality of World's: And I remember well what ſhe ſaid a few Days after.

I have looked over your Books, Sir, ſaid ſhe, as my way is, firſt *curſorily*, and I intend to give it a *very careful ſecond Reading*; but I perceive by it, you have cut out much more Trouble for yourſelf, than perhaps you imagined: For I find there are many Things previouſly neceſſary to the underſtanding it, which you muſt oblige me with explaining; but, continued ſhe, a Converſation of that kind with me, I doubt, will be too dull and tedious, ſince I am not bleſſed with any of thoſe ſhining Qualifications, with which Mr. *Fontenelle* hath complimented M. *la Marquieſe*; I ſhould indeed, ſaid ſhe, except *thoſe two*, which I ſuppoſe, in Complaiſance to our Sex, he makes the Foundation of Philoſophy, *viz.* *Ignorance* and *Inquiſitiveneſs*; for thoſe, I am ſure, I have in Perfection, as you have long experienced.

I need not mention the Return I made, nor how prettily ſhe changed the Diſcourſe to ſomething more general, when ſhe found I was going to ſay juſt things of her; thoſe that knew her, do not want to be reminded of the many Beauties, both of Mind and Body, which rendered Lady *M*—— one of the moſt agreeable Perſons of her Sex; which yet, were ſhe living, though a juſt Debt to her Merit, I muſt not have ſaid, for fear of offending her Modeſty.

All that is neceſſary to introduce what follows, is to inform you, that ſome Years before her Death, when I went to viſit that accompliſhed Lady at her Country Seat, I was a little ſurprized to find her, the next Morning after my Arrival, ſtudiouſly viewing a Pair of large Globes, which ſtood in the Drawing-Room, looking into the Garden, and which I uſed to make my Place of Study.

Good Morrow, ſaid I, Madam, what! hath *Fontenelle* made an Aſtronomer of you in good earneſt? Are you really contemplating the Order and Motions of the heavenly Bodies? Or are you rather ſeeking on the earthly Globe, where to make new Conqueſts?

The Hiſtorians fooliſhly repreſent *Alexander* the Great, as weeping, that he could carry *his* no further than over all the World; but I am ſure, were he preſent now, to ſee you in that Poſture commanding the *Globe*, and giving what Turns you pleaſe to it; that Thought of your humble Servant's would appear juſt enough:

Had the *Pellæan* Chief thy Form but view'd,
With far more Haſte he had the World ſubdu'd:
Proud at thy Feet to lay the mighty Ball,
Whoſe Eyes were form'd to triumph over all;
And then moſt juſtly had he wept to ſee,
One World too mean an Offering for thee!

O! Sir, ſaid ſhe, your Servant, I doubt you did not reſt well laſt Night? What did your Imagination carry you into the poetical Regions of *Fairy Land*, that you awake with Verſes in your Mouth this Morning? But to ſpeak ſeriouſly, I wonder you do not bluſh to paint ſo much beyond the Life, and yet ſuppoſe the Picture to be like any one; you affect to imitate our great Painters; if we ſit to them, they make us all handſome; but they do it to ſhew themſelves, not us, and they do not care ſo much whether it be like or no, ſo it be but a fine Picture; and in this our own Vanity too often indulges them.

But pray, added ſhe, let us lay aſide all theſe Fooleries; and be ſo good as to be ſerious with me for an Hour or two: I have a great mind to be let a little into the Knowledge of theſe Inſtruments, *the Globes*;

Globes; and to know ſomething of the firſt Principles and Rudiments of *Aſtronomy*; or elſe I find I ſhall loſe half the Beauties of that very entertaining Book Mr. *Fontenelle*'s *Plurality of Worlds*, which you formerly obliged me with, as well as perhaps be led into ſome Errors by it: And do not deſpiſe and neglect me becauſe I am a Woman. I have heard you ſometimes ſay, you thought that there was no difference of Sexes in Souls; nay, that *our* Parts and natural Capacities were often *equal*, at leaſt, if not *ſuperior*, to thoſe of Men. But perhaps there were ſome particular Reaſons for your ſaying ſo then, which now altering or ceaſing, your Judgment and Opinion may have done ſo too.

I was going to aſſure her, that I was ſtill of the ſame Sentiments, when putting on a forbiding Look, with a ſerious Countenance ſhe proceeded thus:

Theſe *Globes*, Sir, came too late to accompany a Relation of mine to *India*, his Ship having ſailed before they were finiſhed, which is the Reaſon you ſee them here; and I have ordered them to be ſet out this Morning, and ſhall do ſo from

Day to Day, though without obliging you to what *Fontenelle* had with the *French* Lady, an *entire Week's Conference.* But I have a great mind to learn, from my Friend, ſomething of the Nature and Uſe of them; for they appear to be made and finiſhed up with that *Curioſity* and *Care*, that ſure ſome very uſeful Knowledge is to be learnt from them; And is it not barbarous in you Men to confine it all to yourſelves?

Madam, ſaid I, you will give me a new Riſe to value any Thing that I underſtand; if I can render it acceptable to you.

Well then, Sir, ſaid ſhe, all Compliments apart, both to yourſelf and me, pray let us go to our Buſineſs, the Tea will not be ready this Hour, and there is a little too much Dew for us to take a Walk in the Garden. Let me underſtand then, firſt the Difference between theſe two *Globes*, and why one hath the Cities, Countries, and Places of the Earth drawn on it, like a Map; and the other *Circles* and *Stars*, and theſe odd uncouth Figures of Beaſts, Birds and Fiſhes: Pray why do they turn round? What doth this Braſs Hoop ſignify in which they hang? For I perceive that it alſo hath Numbers engraved upon it: And what doth this *broad wooden Thing* ſerve for, that hath the Days of the Month and other Letters, as well as Figures, paſted upon it?

I am glad, ſaid I Madam, by the warm manner of your Enquiry, to find that you are in earneſt; and I have often wiſhed that the ſame Curioſity and Love of Knowledge would inſpire more of the fair Sex, for it would mightily enlarge their Empire and Power over ours, by endowing them with more real and laſting *Beauties*, ſuch as would improve with Time, and ſtrengthen even in Age itſelf. But as to your preſent Queſtions, Madam, I will give you the moſt ſatisfactory Returns I can.

And firſt, Madam, it will be neceſſary to acquaint you with the meaning of the Word *Globe*, and what the Properties, in general, of ſuch a Figure or Body, are.

Your Ladyſhip is to undeſtand then, that a Globe is a round Body of ſuch a Nature, that every Part of it's Surface or Out-ſide, is at an equal Diſtance from one Point within it, which is called the Center. This Body is alſo ſometimes made a *Sphere*, with regard to Aſtronomical Speculations; and this *Science* which you are now inquiring into, is hence called, *The Doctrine of the Sphere.*

I think I underſtand you, ſaid ſhe, the Figure of a Globe is not flattiſh like that of a Cheeſe or a common Ninepin-Bowl; but rather like a Boy's Marble, or a Bullet caſt in a Mould.

Exactly right, Madam, ſaid I; and further you are to know, that a ſtraight Line ſuppoſed to be drawn through the Center of this Globe any where, from one oppoſite Point of the Surface to the other, is called a *Diameter*.

I thank you, ſaid ſhe, for that Explication, Sir; I have often met with the Word, but never knew *fully* what Diameter ſignified before: But now I know what the ingenious Mr. *Butler* meant, when ſpeaking of the Moon, he ſaith, that *Sydrophil* knew

What her Diameter to an Inch is,
And prov'd ſhe was not made of green Cheeſe.

And now I know what the Plummer meant the other Day, when he talked of a Pipe of Lead of ſuch a Diameter; I now know the Meaning of *Diametrically oppoſite*, &c. But, pray, Sir, go on.

You will next ſee eaſily, Madam, ſaid I, that if a Globe were at liberty, and any Power or Force at hand to move it, it would eaſily turn or roll round any one of it's Diameters, as this Globe doth round this *Wire*; which particular *Diameter*, is called therefore it's *Axis*; as being the *Axletree* on which it turns. But though this be true of the Nature of a Globe in general, yet the *Axis*, as we call it, of the Earth and Heavens, by the Will of our All-wiſe Creator, is one *fixed and determinate Line*; and about this the fixed Stars are uſually ſuppoſed to revolve, without ever changing their Diſtance, or deviating from one another, or from it.

I am mightily pleaſed, returns ſhe, with the Nature of theſe *Globes*, becauſe they are unbiaſſed and indifferent, as to this or that particular way of turning: And I fancy it to be a good Emblem of the Freedom of our Minds in the State of Innocence, when they firſt came out of Nature's Hands; they were then perfectly at liberty to move any way, which they liked beſt: And I dare ſay, that all the wrong Biaſſes and particular Turns that we find in any of them, are owing to the Weight or *Power*, as you call it, of our own corrupt Affections.

You moralize excellently well, ſaid I, Madam, and are very juſt in your Notions of the Deity.

But ſhe went on, and ſaid; Yet I think we might be glad to receive from the firſt Mover and Author of all Things, ſuch a *determinate Way of moving*, as you ſay God hath given to the Heavens end the Earth; for our own whimſical Motions, Turnings and Shiftings, ſeem to be as unaccountable as they are various.

But pray, ſaid ſhe, let me underſtand what you ſay as to the preſent Point a little further; Do the Heavens and the Earth all really move round about one *Axis*, as theſe two Globes do round theirs? And are the *Poles* thus beautifully deſcribed by Mr. *Dryden*, the two Ends of this Axis?

POLES.

Two Poles turn round the Globe, one ſeen to riſe
O'er *Scythian* Hills, and one in *Lybian* Skies;
The firſt ſublime in Heav'n, the laſt is whirl'd
Below the Regions of the nether World:
Around our Poles the ſpiry Dragon glides,
And like a wandring Stream the *Bears* divides,
The *Leſs* and *Greater*, who by Fate's Decrees
Abhor to dive beneath the Southern Seas;
There, as they ſay, perpetual Night is found,
In Silence brooding on th' unhappy Ground:
Or when *Aurora* leaves our Northern Sphere,
She lights the downward Heav'n, and riſes there;
And when on us ſhe breathes the living Light,
Red *Veſper* kindles there the Tapers of the Night.

DRYDEN's *Virgil*.

Shall I ever come to know what theſe *Poles*, and *Dragons*, and *Bears*, mean?

Very eaſily, Madam, ſaid I, and you will find that the *Motion of the Earth alone round it's Axis* will ſufficiently account for all the reſt; for theſe *fixed Stars* do not in Reality move at all, but only appear ſo to do. And you muſt know, that there is one Star, or a Point very near it, towards which this *Pole*, or End of the Earth's *Axis*, (which is called the *North Pole*) doth always point: This is the Star here on this Celeſtial Globe, and if it be fair and the Sky clear, in the Evening, I will ſhew it you in the Heavens: It is ſaid, by Aſtronomers, to be in the Tip of the Tail of the *Little Bear*, a *Conſtellation of Stars* ſo called; you ſee there are Eleven of theſe Stars in all, placed on the Globe within the *Picture* or *Figure of a Bear:* The Reaſon of the Figure I will tell you hereafter.

Pray, ſaid ſhe, good Sir, do not take it amiſs if I interrupt you with one Queſtion: Is this *Tip* of the Bear's Tail, *that celebrated Tip* of *Cardan* the Conjurer; who, as *Butler* ſaith,

Firmly believ'd great States depend
Upon the Tip of th' Bear's Tail's End,
That as ſhe whiſk'd it tow'rds the Sun,
Strow'd mighty Empires up and down.

The very ſame, Madam, ſaid I.

Go on then, ſaid ſhe.

This Star here by the Wire, Madam, ſaid I, we call the *Pole Star*, and the Point near it, through which the Wire runs, the *North Pole* of the World. And let the Earth be where it will, in it's annual Courſe round the Sun, this *North Point* on the Earth, and here placed on the Globe, will always be either exactly or nearly under that *North Pole* Star or Point, in the Heavens. But of this more when I ſhall further explain to you the Motions of the Earth; and this Poſition of the Earth's Axis is ſo firmly fixed and determined by the Author of Nature, that from it there hath never yet been obſerved any conſiderable Variation.

Pray, Sir, ſaid ſhe, proceed: When I come to look over *Fontenelle* again, I perceive I ſhall underſtand him and you much better.

Madam, ſaid I, the outward Figures of theſe two *Globes* you ſee are nearly alike; but though they are hung alſo, and fitted up alike, yet they are almoſt as different from one another in their Natures and Properties, as are the different Regions that they repreſent.

This Globe, which is deſigned to ſhew the Face of the *Earth*; and which therefore is called the *Terreſtrial Globe*, is truly and properly a Repreſentation of it, round or ſpherical as that nearly is, and it hath the Sea and the Land, with all the Regions, Countries, Nations, Iſlands and Cities drawn upon it; juſt in that Order and Figure, that they are, in Reality, on the Face of the Earth itſelf; and it is, if carefully drawn, a true Map, or Deſcription, of what is uſually called *The World:* Whereas, all thoſe flat Maps and Charts, which you ſee drawn upon Paper, cannot be accurately ſo, though they are exact enough for common Uſe.

That Word *World*, ſaid ſhe, I cannot get over without reflecting, what weak, vain, and ſilly Mortals we are: We too often take this *poor Spot of Earth* to be the only *World* worth inquiring after; and ſo we can but acquire a little of it's Dirt, we neglect all Care for an eternal Manſion in the Heavens. And further, I have no Patience with *Ptolemy*, I think they call him, and his Aſtronomers, that will needs have the mighty Sun, and all that infinite Orb of fixed Stars, to be made only for the Sake of *this little dirty Planet*, as I remember ſomebody calls it; and to have no other Uſe or End, but only to dance round it, which yet, as I have heard, is a mere Point, and ſcarce viſible to an Eye placed in ſome of the other Planets.

But to go on with my Leſſon: Good Sir, ſaid ſhe, is the Figure of the Earth thus really round? and have you any good Reaſons to make you think ſo? For I muſt own I had not till now a Notion of it's being round like a Ball; I took it rather to be round in Compaſs like a Diſh or Plate.

Very many and ſubſtantial ones, Madam, ſaid I; and you will be fully convinced by them, when they occur to your reading hereafter, if you proceed on in that Way you are now going: But, however, the Sun ſhining ſo bright into this Room, will furniſh me *now* with one Argument to make that Notion plain to you. You ſee, Madam, when I hold any ſolid Body in this Light of the Sun, it's Shadow will be nearly like the Shape and Form of that of the Body; when I hold this Book in the Light, it's ſhadow will be ſquare at the Sides, as the Book is; but when I hold this Orange in the ſame Light, the Shadow, you ſee, hath a round Edge; and therefore ſince in the Eclipſes of the Moon, the Shadow of the Earth, which you know, Madam, occaſions the Moon's being covered with Darkneſs, appearing always exactly round or circular, we juſtly conclude that the Figure of the Earth is round or ſpherical too, or elſe the Termination or Out-Line of it's Shadow could never be always in a circular Form.

I thank you for this eaſy and natural Explication, ſaid the Lady, which I think I com-

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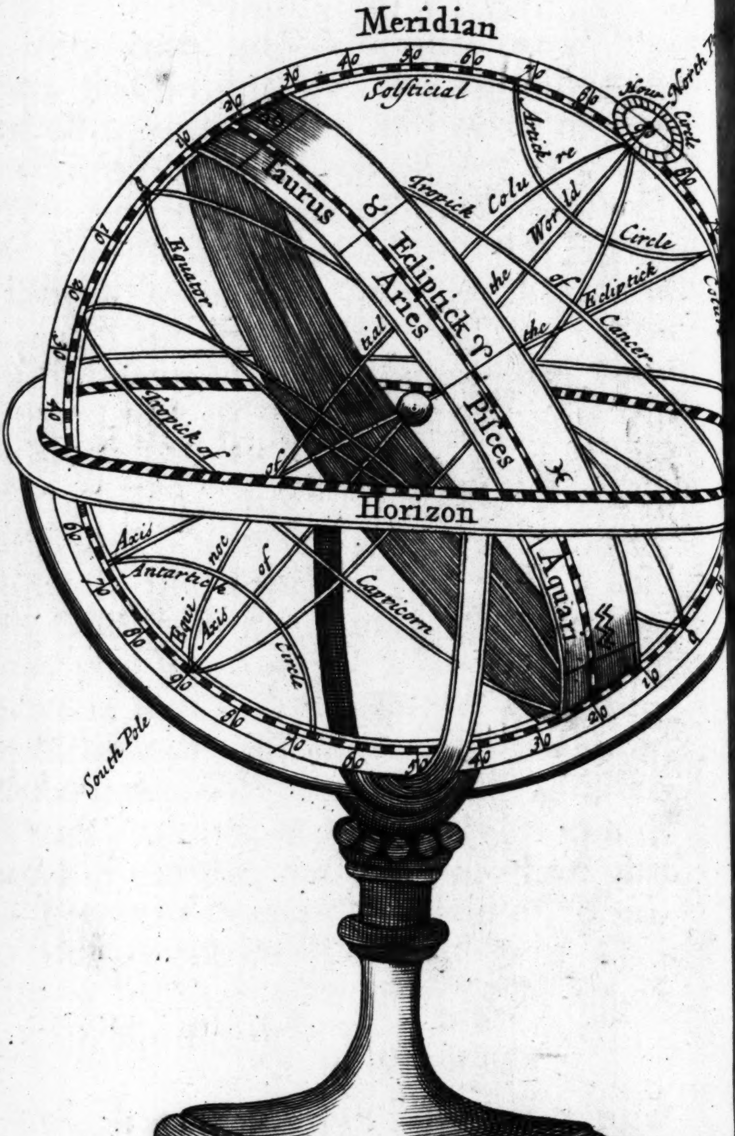
Fig. I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South Pole

I comprehend; and I am beholden to the Sun, that great Fountain of Light, or rather to Him that made it, for being now inſtrumental to diſpel the Darkneſs I had in my Mind before about this Affair; however, being no *Perſian*, I ſhall not worſhip the Sun for it. But pray, Sir, go on with an Explication of the other Globe.

That, Madam, is called the *Celeſtial one*, ſaid I, becauſe it is deſigned for a ***Repreſentation of the Firmament, and the Concave Arch of the Heavens***; and indeed it doth well enough exhibit to us the *fixed Stars*, and the Tracks or Circles of the Sun and Planets, apparent Motions, if you get a right Notion of it as this Figure, which we call an *Armillary* Sphere, will I think help you to obtain: In order to which you muſt now imagine your Eye placed within at the Center of the Globe, or on the little Ball there in the Figure which repreſents the Earth; and that the Spherical Surface of it, on which you ſee the Stars there painted and gilded, were tranſparent like Glaſs; ſo that you could actually ſee through it, not only all the *Circles* drawn upon it, but alſo all the Stars above in the Heavens,

Vid. Fig. 1.

as they really appear there in a bright Night. And if you imagine further, Madam, that ſtrait Lines were drawn from every Star in the Firmament to your Eye ſo placed, as before, in the Center of this Globe, thoſe Lines would paſs through and cut the Spherical Surface of the Globe in proper Points to paint, or to place the Pictures of the Stars upon.

I think, I conceive you right, ſaid the Lady, ſo that if there were Holes in the Surface of this Globe in thoſe Places where theſe Stars are painted upon it, and that my Eye were within at the Center, and the Globe turned, ſo as to conform itſelf to the preſent Poſition of the Heavens above; I ſhould ſee every Star there through it's correſponding Hole in the Globe.

You are perfectly right, Madam, ſaid I, and *Ptolemy* himſelf could not have expreſſed it better. And juſt in that central Point (and juſt ſuch a Point as that is it) do Aſtronomers of his Sect ſuppoſe the Earth to be placed, as you ſee in the Figure, in the Middle of the Sphere of the fixed Stars, which ſeem to revolve round about it, once

Vid. Fig. 1.

in 24 Hours, becauſe the Earth doth turn round her own Axis, though a contrary Way in the ſame Time.

Of this, replied *Clarella*, I have gotten a tolerable Notion from what you ſaid before, and from the *French* Author: But pray let us now go on with our Globes here; What is the Meaning of this *broad wooden Circle* placed round each of them, and what is *it* called?

Madam, ſaid I, it is called *The Horizon*; which is a *Greek* Word that ſignifies a *Limiter* or *Determiner*. And to conceive it right, imagine yourſelf placed, as before, on this poor little Earth, within that immenſe cœleſtial Globe; which you are to ſuppoſe now to be millions of millions of Times greater than it really appears to be: Then you know, if you look round you on the Earth, it's Surface will extend every Way from your Eye, like a vaſt Plain; which will be under your Feet, and to which your Body will be perpendicular or upright: This Plain ſtretching all round you every Way as far as your Eyes can ſee, in a flat open Country where no Hills interpoſe, or on the Surface of the Sea, will ſeem to divide or cut the concave Orb of the Stars, or the Sky, into two Parts (which they call *Hemiſpheres*) the one ſeemingly above this Plain, which therefore they call the *Upper*, and the other apparently below it, which therefore they call *the lower Hemiſphere.* Such a Plain as this is called *the Horizon:* And if it be really that which any one's particular Eye makes upon any occaſional View, it is called *the ſenſible Horizon:* But if you imagine this Plain, as you may eaſily do, to paſs through the very Center of the Earth on the Surface of which you then ſtand, it is called *the real or rational Horizon*; becauſe that doth really or actually divide the ſtarry Regions into two equal Hemiſpheres; and both theſe Horizons are well enough repreſented by that wooden Circle, which you now lay your fair Hand upon.

I hope I take you right, ſaid ſhe; and now begin to underſtand better the Meaning of many Expreſſions which have often occurr'd to me before, but with leſs Light. But why do you ſo cautiouſly uſe the Words *apparently above and below?*

Becauſe, ſaid I, Madam, there is in reality no ſuch Thing as any Difference between *above and below*: The Heavens are every where *above* or *without* what they contain; but we, taking our Ideas of things from ourſelves, do agree to call that *above* or *uppermoſt* which is over our Heads, and that *below*, which is *beneath* us, or down under our Feet: And therefore as we call that *Concave* half of the Region of the fixed Stars, which we ſee above our Horizon, the *upper Hemiſphere*; ſo the other Half takes the Name of the *lower Hemiſphere*.

I am mightily pleaſed, ſaid the Lady, with theſe Celeſtial Beings that are ſo perfectly above all the poor Trifles of *Place* and *Station*; with which we Mortals make ſuch a Buſtle here below: Eſpecially thoſe of our Sex; as I will honeſtly own to you, now you are my Maſter and Teacher; for as *Butler* hath juſtly obſerved,

To us the Joys of Place and Birth
Are the chief Paradiſe on Earth:
A Privilege ſo ſacred held,
That none will to their Mothers yield,

But rather than not *go before*,
Will forfeit Heaven at the Door.

But let us go on. I perceive, ſaid the Lady, that theſe Horizons will always vary as we ſhift the Place of our View.

Yes, Madam, ſaid I, and ſo will the Hemiſpheres too that they determine.

And yet, ſaid ſhe, we are often ſo vain as to take our little narrow View or Horizon for the Bounds of all that is to be ſeen; and judge, that what is not within our Hemiſphere, to be either nothing at all, or at leaſt not worth our knowing or inquiring after; for we are always ſo vain as to deſpiſe what we do not underſtand. But I interrupt you with my impertinent Reflexions; pray, Sir, go on.

I beg you to take notice farther, ſaid I, Madam, that when the Sun, or any Star or Planet, appears at the Eaſtern Edge of our Horizon, we ſay it is *Riſing*; and when it has got quite above it, we ſay it is *Riſen*, or is up. On the contrary, if it appear towards the Weſtern Edge of it, we ſay it is *Setting*; and when it is gotten below it, we ſay it is *Set*. And this Riſing and Setting always reſpects the Senſible, and not the Real Horizon.

But what is the Meaning of theſe Circles, demands ſhe, which I ſee drawn here upon the Board of the Horizon, and on both Globes alike?

The outermoſt of them, Madam, ſaid I, repreſents the *Points of the Compaſs*, as they are called by our Seamen; who make Uſe of an Inſtrument called *the Compaſs*, to ſteer their Ships by at Sea

Pray let me know a little more of that Matter, ſaid ſhe, for it is a Thing I have heard much Talk of.

You have ſeen, no doubt, Madam, ſaid I, a *Loadſtone*; and know that it hath that wonderful Virtue, among others as ſtrange, that if a Needle or Iron Wire be rightly drawn over it, that Needle will ever after that, when at Liberty, *point*, as they call it, due North and South.

You are now, ſaid ſhe, ſo very good, that I think I muſt feed your Vanity, by owning, that I was once much pleaſed with ſome Verſes of yours occaſionally given me; but am more ſo now, becauſe I underſtand them better: after you had talked in your uſual Way of Love and Conſtancy, and I know not what; you thus, as I remember, concluded,

So when the Needle hath been once drawn o'er
The Loadſtone's Poles, and felt its wondrous Power,
'Twill e'en in Abſence keep it's Truth and Worth,
And always *point* tow'rds it's beloved North:
But when it once the Magnet's Preſence gains,
With Joy it trembles and the dear Object joins.

Madam, ſaid I, you do me and my Trifles a great deal of Honour——

Huſh! ſaid ſhe, not a Word! I won't now allow you one Syllable of Trifling; be quiet and go on with your Lecture.

Pleaſe to let me inform you then, Madam, ſaid I, that ſuch a Wire as this, ſo *touched*, as they call it, or directed by the

Power of the *Magnet*, or Loadſtone, they put into a round Piece of Paſteboard, on which they draw a Circle; dividing it as this on the wooden Horizon of the Globe is, firſt into four Quarters, for Eaſt, Weſt, North and South, placing the Point of North over that End of the Wire which will point that Way; then they divide each Quarter into Halves; and by that Means they make in the Whole 32 Diviſions, which they call *Points*; and which are there and here expreſſed by the initial Letters of their Names after this Manner: And therefore the Uſe of that Circle on the Horizon of the Globes is to ſhew, on *what Point of the Compaſs* the *Sun*, or any *Star* or *Planet*, apparently *Riſes* or *Sets*; as I ſhall ſhew you more fully hereafter.

Vid. Fig. 2.

Well! ſaith ſhe, I fancy myſelf half a Sailor already; but for all that I muſt confeſs ingenuouſly to you, that I do not know how to find the Points of Eaſt, Weſt, North and South, in the Heavens, or on the Earth, unleſs I ſee a *Church*, which, they ſay, uſually ſtands Eaſt and Weſt.

Madam, ſaid I, that is eaſily known, by the Noon-day, or Meridian Sun; for the Sun at Twelve o'Clock being always full South, when you turn your Face towards it, the North will be on your Back, the Eaſt on your Left, and the Weſt on your right-Hand.

That is true, ſaid ſhe; but as obvious as this Obſervation is, I never made it before. And really the Education of us Women is ſo ſilly and crampt, that, generally ſpeaking, we are never taught, nor enured to think of any Thing out of the common Way, and beyond the Legend of the Nurſery: Nothing but our *Work*, a little *Houſewifery*, and a great deal of *Goſſiping*.

But pray let us go on: The next Circle I perceive is only an Almanack, with both our Own, and the Foreign or New Stile, or Way of accounting Time: But pray Sir, of what Uſe is this innermoſt Circle, and how it is divided?

Madam, ſaid I, all Circles on the Globes are ſuppoſed to be divided into 360 equal Parts, which they call *Degrees*, and each

Degree into 60 leſſer Parts, which they call *Minutes*, and ſo on, by a Sub-diviſion by 60 ſtill, as far as you pleaſe. This Circle is deſigned to ſhew us what we call the *Sun's Place* for every Day in the Year; and therefore is divided actually into 12 Parts, which are diſtinguiſhed here, you ſee, by theſe Pictures of 12 eminent Conſtellations, or Parcels of Stars; and which, becauſe they do *ſign* or mark out a *particular Place* in the Heavens, where the Sun is, or appears to be, every Month, have been called the *Twelve Signs* of the Zodiac: And each of theſe *Signs* is divided into 30 equal Parts or Degrees which make up the whole 360.

Hold a little, Sir, ſaid the Lady, for I have now ſo many Things to aſk you, that I know not where to begin ———

Madam, ſaid I, all the Affair of the Zodiac, of the 12 Signs, and of the Sun's apparent real Motion through them, I will fully explain to you hereafter: And all you need know now is, That it is the Uſe of this Circle to ſhew you in what Degree of it, or in *what Place* or Part of any of the 12 *Signs*, in which the Sun is ſuppoſed to be at Noon, anſwers to each particular Day of the Month. As for Inſtance; You ſee this Day, *May* the 20th, is placed in the Calendar, juſt againſt the firſt Degree of (♊) *Gemini*; and therefore that is the *Sun's Place for this Day*.

Since I muſt wait, ſaid ſhe, I will be patient, and be content to be taught in your own Way; but I will never forgive you if you do not tell me *juſt now*, why 360 was *only* pitched upon for the Number of Diviſions, or, as you call them, *Degrees of your Circles*; and why any other Number would not have done as well?

Madam, ſaid I, any other *greater Number* that could have been broken into *Parts without Fractions* would have done better. But they had a particular Reaſon to pitch upon this of 360, which yet I beg you will excuſe me from telling you now, becauſe it will be much more uſefully explained hereafter, and ſave a great many Digreſſions at preſent.

Well! ſaid ſhe, I am ſure you keep me out of this only to mortify me, and to try my Patience; but that I may not tire *yours*, I ſubmit.

You are ſo moderate and eaſy in your Deſires, Madam, replied I, that I will now go out of the common Method, and explain all that Matter to you immediately.

The ancient Aſtronomers obſerved of the Sun, that beſides his apparent Motion round the Earth in 24 Hours, by which he made, as they ſuppoſed, Day and Night; the former when he was above, the latter when he was below the Horizon of any Place; which daily or *diurnal* Motion (by the by) they ſuppoſed to be always made either in this very Equinoctial Circle, or in ſome other leſſer ones parallel to it, or equally diſtant from it: Theſe Parallel Circles alſo they ſuppoſed to be, in the Summer Half-year on the *North-ſide*, and in the Winter on the *South-ſide* of the Equinoctial. And they took Notice, Madam, that beſides this Diurnal Motion (which appeared to be circular) the Sun had alſo in Appearance a progreſſive one, *forward* on in another circular Track in the Heavens; which, becauſe they found that when ever the Moon came into the very ſame Circle, there would be an Eclipſe of either *Her*, or of the *Sun*, they called the *Ecliptic*. This is the Circle here on the Globe, which lies oblique to, or *aſkew*, and cuts or croſſes this other, which is drawn exactly in the Middle between the Poles, and is called the *Equinoctial* or *Equator:* This Ecliptic Circle alſo, becauſe they perceived that the Sun never deviated from it in his annual Motion towards either Pole North or South, they called the *Way of the Sun:* And they found, that in the Time of our Common Year, he would appear to go quite round, or paſs ſucceſſively through all the Parts of this Circle.

But, ſaid the Lady, how could they determine that? For when the Sun was above the Horizon, no Stars at all could be ſeen, to diſtinguiſh his Place or Situation by.

Your Objection is juſt, ſaid I, Madam, if you conſider the Thing *after* the Sun was actually Riſen, and juſt *before* his Setting: But they took Notice of thoſe Stars which were at or near the Edge of the Horizon *before* his Riſe, and ſuch as were there *after*

fter his Setting; and found that the Sun ould not continue to riſe and ſet always t the ſame Diſtance from the ſame Stars; ut if, for Inſtance, on *March* the 10th, e would riſe and ſet near theſe Stars which ou ſee here placed on the Globe within this Conſtellation called *Aries*, about a Month after they found that he would riſe nd ſet with thoſe in *Taurus*, which lie a 12th Part of the whole Circle more this Way or forwards on, as the Numbers ſhew, o the Eaſtward: And after this Manner the Sun proceeding ſtill forward every Day, they found that at the End of 12 Months he would ſeem to have gone entirely round in this Circle, and to riſe and ſet ſucceſſively with or under all the fixed Stars, which are in or near this circular Tract called the *Ecliptic*.

But, pray, Sir, ſaid ſhe, what do you mean by *under* the fixed Stars? Why do not the Sun move *in among* them, and along with them?

No, by no Means, Madam, ſaid I, the fixed Stars are probably farther, a long Way from the Sun, than that mighty Luminary is from us; and the Meaning of the *Sun's Place*, or his being in ſuch a Sign, is only his being for ſuch a Time under that Star or Conſtellation, or between that and our Eyes; ſo that if a Right Line were drawn from that Star to your Eye, it would paſs through the Center of the Sun.

I begin, ſaid the Lady, I think, to comprehend this a little better than I did; but, pray, Sir, what is the Meaning of the Word *Zodiac*, which you uſed a while ago, when you began to talk about the Sun's Motion?

The ancient Aſtronomers, Madam, ſaid I, to diſtinguiſh theſe Conſtellations, or *Setts of Stars*, under which the Sun conſtantly appeared to move in his annual Courſe, gave them particular Names: The firſt they called *Aries*, or the Ram; the ſecond *Taurus*, or the Bull, *&c.* and becauſe theſe Names were moſtly taken from *Animals*, or living Creatures, they called it the *Zodiac*; which is a *Greek* Word expreſſing ſuch a Collection.

Well, ſaid ſhe, as for your *Greek*, I know nothing of the Matter; but now I begin to find

ind out the juſtneſs of thoſe Lines, in *Hulibras*, wherein he deſcribes *Sydrophil*'s Surprize at the Diſcovery of his new Star, ocaſioned by a Lanthorn at the Tail of a School-boy's Kite:

> 'Tis not among that mighty Scrowl,
> Of Birds, and Beaſts, and Fiſh, and Fowl,
> With which, like *Indian* Plantations,
> The Learned ſtock the Conſtellations.

And theſe, I ſuppoſe, are the Pictures, coninued ſhe, of thoſe *animated Stars*, or rather s *Butler* hath it in the ſame Place, the *Signs* f *thoſe*:

> Nor thoſe that drawn from *Signs* have been,
> The *Houſes* where the Planets inn.

Mighty well remembered, ſaid I, Maam, you ſee at once why the Aſtronomers all them the *Twelve Signs*, becauſe, as I aid before, they *ſign* or mark out the Place f the Sun in the Heavens; and alſo why he Aſtrologers called them *Houſes*, becauſe hey aſſigned them as Dwellings or Places f Abode for the Planets.

O! ſaid ſhe, now you talk of Aſtrolog I muſt aſk you a few Queſtions about *tha* either now or ſome other Time; for I lon to know whether there be any Thing i that Art or no; for I think I have hear you throw out ſome ſuſpicious Word about it.

Madam, ſaid I, if you pleaſe to go o with your Aſtronomy, you will ſoon kno enough to deſpiſe that vain and fooliſ Cheat, as a Thing perfectly beneath yo Enquiry into.

Very well, ſaid ſhe, and ſo if I will b an Aſtronomer, it ſeems, I muſt at onc bid adieu to that darling Pleaſure of ou Sex, Curioſity, and the Deſire of knowin our Fortunes; this is very hard, and yo are really, Sir, a very bad *Woman's Ma* you have philoſophized me out of many fair Pleaſure already; Cenſure, Satyr, an Goſſiping are almoſt gone, and muſt de *Inquiſitiveneſs* follow them too? It ſhall never be, let it be never ſo ſilly; I rememb what *Butler* ſaith,

Doubtle

Doubtleſs the Pleaſure is as great,
Of being cheated, as to cheat;
As thoſe receive the moſt Delight
Who leaſt perceive a Jugler's Slight;
And ſtill the *leſs* they underſtand,
The *more* admire the Slight of Hand.

But I have not Time to quarrel with you, and to diſpute it out with you now, pray, therefore, Sir, go on, about the Sun's Motion, a little farther.

You muſt know then, Madam, ſaid I that theſe venerable Star Gazers, finding the Sun apparently to run through this Zodiac, in twelve Months, or a Year's time, aſſigned one Part of the Circle to a Day's Motion: and becauſe there are but a few more than 360 Days in a Year, they ſuppoſed this Circle of the Sun's annual Motion, to be divided into 360 equal Parts, which they called *Degrees*, as I told you before; and hence all Circles on the Globes came to be divided after the ſame Manner.

I thank you, Sir, ſaid ſhe, now this Matter begins to clear up to me; have you any Thing more to teach me about this Circle?

Only the Explanation of a few Terms, or Words, which you will find uſed about it, ſaid I, Madam: For you muſt know, that the Aſtronomers call the Diſtance of the *Sun's Place* at any Time of the Year, from the Beginning of *Aries* here, which you ſee is placed at the Eaſtern Point, where this Circle of the *Ecliptic*, and that of the *Equinoctial* croſs one another, they call that Diſtance, I ſay, his *Longitude*; and though the Sun himſelf apparently moves always in one Circle, exactly in the Middle of the *Zodiac*, that is, in the *Ecliptic*, yet the Moon, and the other Planets, do not, but ſometimes are 5 or 6 Degrees to the North, and at others, as far to the South of this Circle; and this Deviation or Diſtance they call their *Latitude*; and you ſhall be ſhewn hereafter how to meaſure it; and the ſame Word is uſed alſo, with Reference to thoſe fixed Stars which are not in the *Ecliptic*, but are diſtant from it, any Way, towards either of the Poles; for the Diſtance of a fixed Star from the *Ecliptic*, is alſo called it's *Latitude.*

But, pray, Sir, ſaid ſhe, is not the Word *Latitude* uſed alſo with Reference to the *Terreſtrial Globe?* Surely I have heard my Brother ſpeak of *Pekin* in *China*'s lying in ſuch a Latitude; of the Latitude of *London*, and of his Ship being haraſſed by a Storm, in ſuch a *Latitude*; but I muſt own I never knew the Meaning of it: Am I Aſtronomer enough to be taught that now?

Yes, Madam, ſaid I, and you will very eaſily comprehend it: Pleaſe to turn your Eyes to this Terreſtrial Globe; this Circle which lies exactly in the middle, between the two Poles of the Earth, is here called the *Equator*, and by the Sailors *the Line*; all Places which lie under it, or which have the Equinoctial in the Heavens, paſſing over their Heads, are ſaid to have no *Latitude*; but all *other Places* that lie at any Diſtance from it, either North or South, are accordingly ſaid to have North or South Latitude: And it's Quantity is known by turning the Globe about till the Place come to this *Brazen Circle* in which the Globe

hangs,

hangs, and there *the Place* will ſhew its own *Latitude*, in Degrees upon that Circle: Thus, you ſee, Madam, when I bring *London* to this Braſs Circle, it appears to lie on the North Side of the Equator, in 51½ Degrees diſtant from it.

Mighty well, Sir, ſaid ſhe, I now conceive what *paſſing* or *croſſing the Line is*, which I have heard the Sailors make ſuch a Fuſs about; and I have read of ſtrange Ceremonies and Duckings, which they make young Navigators undergo, at the firſt Time of their *croſſing the Equator*: I perceive now, alſo, the true Meaning of ſeveral Allegorical Expreſſions, which, no doubt, are taken from hence, ſuch as being a *Latitudinarian in Notions*, &c. But pray, Sir, let us go on; now you mention that *Braſs Hoop*, in which the Globes hang and turn round, pray let me know it's Name and Uſe?

That Brazen Circle, Madam, ſaid I, is called the *Meridian*; and it is a greater Circle of the Sphere, which is ſuppoſed to paſs through the *Zenith* and *Nadir* of any particular Place, through the North and South

Points of it's Horizon, and through the Poles of the World.

I ſee, ſaid ſhe, the latter Part of what you ſay; but pray, what do you mean by the Terms *Zenith* and *Nadir?* the former of which Words I have often met with in Books, but never knew the Meaning of it.

It is an *Arabic* Word, ſaid I, Madam, and ſignifies that Point in the Heavens that is directly over your Head, as *Nadir* doth the oppoſite one in the lower Hemiſphere, that is under your Feet, at the oppoſite End of a Diameter of the Earth: And this Brazen Circle is called the *Meridian*, becauſe, whenever the Sun comes to the Meridian of any Place on the Earth, in his daily Courſe, it is then, what the *Latins* called *Meridies*, i. e. *Mid-day*, or exactly *Noon* there.

O! Sir, ſaid ſhe, this *Aſtronomy* is mighty inſtructive; I now underſtand the juſt Meaning of ſuch Expreſſions as theſe,

There Vice did in it's *Zenith* reign,
Our bright *Meridian* Sun decline, *&c.*

But pray let me know the Uſe of this Circle here on the Globes.

I ſhewed you juſt now, ſaid I, Madam, That on the *Terreſtrial Globe* it ſhewed the *Latitude* of all Places, which, by being brought ſucceſſively to it, as the Globe turns round it's Axis, do each receive it for their own Meridian, for it is all one as if a different Meridian had been actually drawn on the Globe through every Place.

No doubt on it, ſaid ſhe, for it is the ſame thing, *as to meeting*, whether the Mountain walks to *Mahomet*, or he ſtalks to the Mountain: But methinks this *Earthly Meridian* is either very lazy, or elſe takes great State upon him, that all Places muſt come to him, while he ſtands and ſtruts here, and will not ſtir the leaſt Step towards them. —— Have you any thing more to tell me about this *Man of Braſs*; *Spencer* did wiſely to make his Man *Talus* of Iron, that was to be *Arthegal's*

Page, and to bear ſo buſy and active a Part in his Story.

Madam, ſaid I, this Braſs Meridian ſerves alſo, by it's moving thus, round, North or South, in this perpendicular Situation to the Horizon, to elevate or raiſe the Pole of any Place as much above it's Horizon in Degrees, as is the Latitude of that Place, or it's Diſtance from the Equator; and then that particular Place will be brought to lie in the Zenith, or uppermoſt Point of the Globe.

Pray explain this by an Inſtance, ſaid ſhe.

I ſhewed you juſt now, ſaid I, that the *Latitude* of *London* is found by the Help of this Meridian to be $51^\circ\frac{1}{2}$; raiſe therefore the North Pole ſo, that the northern Edge of the Horizon cut 51° 30′ of this Braſs Meridian, reckoning from the Pole, and then *London* will be in the Zenith Point of the Globe.

I ſee it is, ſaid the Lady, and I believe I ſee alſo the Reaſon why it muſt be ſo; for it is juſt as far (*viz.* 90°) from the

Equator to the Pole, as from the Zenith to the Horizon; ſo that taking away the middle Part, which is common to both, the *Latitude* of any Place, and the *Height of the Pole* above it's Horizon, are all one in Quantity; and ſo I ſuppoſe it is called the *Height of the Pole*, becauſe the *Pole Star*, which is near the Polar Point (as I think you told me) will appear, in the Night, juſt ſo high above the Horizon of any Place, as is that Place's Latitude.

Excellently explained, Madam, ſaid I, and yet I fancy you want to be told further, that the Height, or *Altitude of the Pole Star*, as well as *all other Altitudes* of the Sun or Stars, is taken by an Inſtrument, which hath a circular Edge like this graduated Meridian, divided on Purpoſe into *Degrees*, *Minutes*, &c. with Sights fitted to it, to look up at the Object.

I was juſt going to aſk you about that, ſaid ſhe; for I remember to have often ſeen you peeping up at the Stars, or catching the Sun-Beams with juſt ſuch a kind of thing as you deſcribe: But pray, what Uſe is this Meridian of, on the Celeſtial Globe?

There, Madam, ſaid I, it ſhews the *Declination* of the Sun or Stars, by bringing the Sun's or Stars' Place in the Ecliptic on the Globe to it, as we did the Places on the Earth upon the other Globe, to find their Latitudes.

Declination! ſaid ſhe, there is a *new Word* for me to learn! which, I ſuppoſe, the Aſtronomers have coined, to avoid that of *Latitude*; which, when it relates to the Stars or Planets, I think you told me regards the *Ecliptic* only? Well! I doubt my Head will never retain the Memory of all theſe *Cramp Terms.*

Yes, Madam, ſaid I, very eaſily, when you ſo perfectly underſtand their Meaning, for we only forget what we underſtand but by Halves; things thoroughly known become Part of our Nature, as it were; and People can alſo generally remember what they have a mind to. But, however, if you pleaſe to look over Dr. *Harris*'s little Book of the Globes, you may have your Memory refreſhed at any time very briefly, and yet plainly and fully.

I thank you, Sir, ſaid ſhe, for that Information; I ſhall, I hope, be able to underſtand a little of Books of this Kind, by Degrees: But, pray, have you any thing more to ſhew me, relating to theſe Circles?

Madam, ſaid I, it will be proper for you to know, that as our Aſtronomers make *ſix greater*, ſo they make alſo *four leſſer* Circles of the Sphere; two of which they call the *Tropics*, and the other two the *Polar Circles.* The Meaning of the Word *Tropics* is, *returns back again*; for indeed neither the Sun ſeemingly, nor the Earth really, goes any furthur in it's Annual Courſe, to the Northward or Southward of the Equinoctial than 23 Degrees and $\frac{1}{2}$; but after it hath gone ſo far, *returns* again towards it: And becauſe the Points in the Heavens, where theſe Returns are made, are under the Beginning of the Signs ♋ *Cancer* and ♑ *Capricorn*; they ſuppoſe two Circles to be there drawn in the Heavens and on the Earth, parallel to the Equator; and the moſt Northern of theſe, and which therefore is our Summer *Tropic*, is called the Tropic of *Cancer*, and the Winter, or Southern one, that of *Capricorn*; becauſe they always fall at the Beginning of thoſe Signs.

I like our Earth mightily, ſaid ſhe, for her Steadineſs in her Way, and for her not going too far North or South towards the Poles: I love moderate Weather, and would have it be in neither of the Extremes of Heat nor Cold: But, Sir, this Matter now begins to clear up to me apace; when the Sun is in the Northern Tropic, I ſee our Days are at the longeſt, and all of them longer than our Nights, during the Time of his whole Stay on the North-ſide of the Equinoctial: Whereas the very Reverſe, I ſee, muſt come to paſs, while the Sun is on the Southern Side of the Line. But, pray, of what Uſe are the *Polar Circles?* for I ſee they are drawn on both Globes, as well as the *Tropics*, and juſt as far from the Poles as the Tropics are from the Equinoctial.

Of no very neceſſary Uſe, Madam, ſaid I, but only to help to diſtinguiſh the Terreſtrial Globe into the five Parts, which the Ancients called *Zones*, and which they fancied to be like ſo many *Girdles* or *Belts* (as the Word *Zone* ſignifies) encompaſſing the Earth.

O pray, ſaid ſhe, let me have ſome true Knowledge about theſe *Zones*, for I have heard and read a good deal of them, without being a Jot the wiſer.

The great Space on the Earth, ſaid I, Madam, which lies between the two Tropics, having the Equator paſſing through the middle of it, the Ancients called the *Torrid*, the *Fiery* or *Roaſted Zone*; for they fancied the Sun, keeping always over it, had ſuch a Power here, as to have burnt all things up; and becauſe they had no Knowledge of it, concluded it not inhabitable; whereas it is now known to be very comfortably ſo: Though, no doubt, warm enough to thoſe Inhabitants of it to whom the Sun is ſucceſſively vertical, or directly over their Heads, as you eaſily ſee by the Globe he will be.

Yes, yes, ſaid ſhe, I underſtand that very well; but I cannot help reflecting upon the *Arrogance*, as well as Ignorance, of the Ancients, in ſuppoſing *their* Knowledge to be the Bounds of all things; and glad I am that *we* know ſomething which they did not; for I have heard them ſo much cried up, now and then, by Authors, that I could almoſt wiſh myſelf to have lived among them; but I will, at laſt, take Comfort, and thank God, that I am a *Modern*, and alive now.—But pray go on about your Zones.

Theſe two Spaces of the Earth, ſaid I, Madam, which lie between the Tropics and the Polar Circles, each Way North and South, the old Geographers called the *Temperate Zones*; and as theſe Oriental Sages, and the learned *Greeks* and *Romans*, lived (as you * ſee here) in *one* of them, ſo they did allow the *other* to be habitable alſo.

That was pretty good natured, ſaid ſhe, for I ſuppoſe they never ſaw the Southern *Temperate Zone*, any more than the *Torrid* one.

Not that we can find by Hiſtory, ſaid I, Madam: But to proceed; Theſe ſmall Spaces of the Earth, between the Polar

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* Here on the Terreſtrial Globe I ſhewed her the chief Places of the *Grecian* and *Roman* Empires.

Circles and the Poles, they called the *Frigid Zones*, and did pretty juſtly ſuppoſe them not to be habitable, upon the Account of their Coldneſs; for though we have ſince diſcovered, that it is poſſible to ſubſiſt, and ſeveral of our Ships do yearly go within the Northern Frozen Zone, yet I cannot recommend it to you as a Place much worth your Enquiry after.

O! do not ſpeak any more about them, ſaid ſhe, you make me ſhiver all over with the Thought of them, and my Blood is juſt going to curdle in my Veins; no *Lapland* or *Spitſburghen*; no Whale-Fiſhing Voyages for me.

You ſeem to be really a-cold with the Thought of it, Madam, ſaid I; let me warm you a little with this Deſcription of theſe Zones given by Mr. *Dryden*.

From VIRGIL and OVID.

Five Girdles bind the Skies: The Torrid Zone
Glows with the paſſing, and repaſſing Sun;
Far on the Right, and Left, the Extremes of Heaven,
To Froſts, and Snows, and bitter Blaſts are given;
Betwixt the Midſt, and theſe the Gods aſſign'd
Two Habitable Seats for Human Kind;

And croſs their Limits cut a ſloping Way,
Which the twelve Signs in beauteous Order ſway:
And as five Zones the Ætherial Regions bind,
Five correſpondent are to Earth aſſign'd;
The Sun with Rays directly darting down,
Fires all beneath, and fries the middle Zone:
The two beneath the diſtant Poles, complain
Of endleſs Winters and perpetual Rain:
Betwixt the Extremes two happier Climates hold,
The Temper that partakes of Hot, and Cold.

Well, ſaid ſhe, theſe Verſes have a little recovered my Spirits, as well as refreſhed my Memory, and will, I find, fix in the latter, the obliging Pains you have taken to inſtruct me: But pardon me, good Sir, if I ſtop you a Minute: Mr. *Dryden* here mentions the Word *Climates*; Pray what are they?

Madam, ſaid I, you will find a deal of uſeleſs Stuff in ſome Introductions to Geography, *&c.* about theſe *Climates*; but all that is neceſſary to know of them, is, that the Ancients ſuppoſing two Circles to be ſo drawn parallel to the Equator, on the Terreſtrial Globe, or at that Diſtance one from another, that to ſuch as inhabit the *leſſer*, the longeſt Day, would be a Quarter of an Hour longer, than it is to thoſe who dwell in the *larger:* Then the Space on the Globe between theſe two they call a *Parallel*, and the Double of ſuch a Space a *Climate*; you will eaſily ſee therefore, that theſe Climates muſt leſſen as you go each Way from the Equator to the Poles, and muſt be 24 in Number.

Well! ſaid ſhe, I ſhall not trouble my Head about reckoning theſe *Climates*; but I think I underſtand what is meant by ſuch a Place lying in ſuch a *Climate*, as well as what the Navigators mean by ſailing in ſuch a Parallel, and that will be enough for me at preſent; but I will tire you no longer now, I will get the Book you adviſe me to, which I believe I have above among my Brother's Things; and after I have conned my Leſſon well over, you muſt expect that I ſhall aſk you abundance of Queſtions more.

Within a ſhort Time after this, the Ingenious and Inquiſitive Lady got her Globes ſet out again, and began with me thus:

I have been looking over the little Book you recommended to me, Sir, ſaid ſhe, which I think is very plain and conciſe, and I fancy I am now got to be ſuch a Proficient, as that I am qualified to go through the *Problems*, as the Book calls them, though what that Word ſignifies I do not underſtand.

That *Greek* Word, Madam, ſaid I, ſignifies *ſomething to be done or practiſed*, and I queſtion not but you have ſo well conſidered this Affair, as to be able to work or perform any of theſe *Problems* upon the Globes yourſelf.

I do not know that, ſaid ſhe, but I am reſolved to try, and with a little of your Help, perhaps, I may get through them: Come, pray, let us begin; and, *firſt*, ſhew me how to *rectify* each Globe, as he calls it, and what I ſhall learn by that.

Rectifying the Globes, Madam, ſaid I, is reducing them to ſuch a Poſition, as that they ſhall truly repreſent the Situation of the Circles of the Sphere of the fixed Stars, and Planets; and of the Poſition of the Earth itſelf at any Time aſſigned.

Very well, ſaid the Lady, let us then take his Time of the Year; ſuppoſe *May* 10, 1719; How muſt we begin?

Madam, ſaid I, for common Uſe, look firſt for the Sun's Place, againſt the Day of the Month in the Calendar, on the Wooden Horizon (though if you would proceed to greater Exactneſs, you muſt find the *Sun*'s *Place* in ſome good Tables, ſuch as thoſe which Dr. *Harris* hath given in the ſecond Volume of his *Lexicon*, or ſuch as *Parker*'s Almanac, which I have here in my Pocket, gives you every Year, or elſe you muſt determine it by Calculation, *&c.*) and then finding that Place, or what Degree of any Sign of the *Zodiac* the Sun appears to be in that Day at Noon, which you will find to be then in the firſt Degree of *Gemini*, look it out on the *Ecliptic* on the Globe, and there make, either with a Pencil or with Ink, a Mark to repreſent the Sun for that Day.

But, ſaid ſhe, will not that ſpoil the Globe?

No, Madam, ſaid I, that being varniſhed, the Ink will eaſily come out again, if you rub it with your Handkerchief a little wetted; as ſoon as this is done, you may alſo, if you pleaſe, by the Help of *Parker*'s, or ſome other *Ephemeris* or Aſtronomical Diary, place *all the Planets* on your Globe, after the ſame Manner, allowing for their Latitude, either North or South of the Ecliptic.

Thus the Moon being then in 24° 33′ of *Cancer* ♋, and having about 4° 41′ of South Latitude, take, with a Pair of Compaſſes, thoſe Degrees and Minutes of Latitude from the Meridian, or any great Circle, and placing one Foot in 24° 33′ of ♋, turn the other directly towards the Equinoctial, and there make this Mark ☽ to repreſent the Moon.

After the ſame Method you may place ♄ *Saturn* in 8° 42′ of *Virgo* ♍; and ♃ *Jupiter* in 26° 35′ of *Leo* ♌: Then make alſo this Mark ♂ for *Mars* in 16° 32′ of *Aquarius* ♒: And this Character ♀ for *Venus* in 28° 18′ of *Gemini* ♊: Laſtly, placing *Mercury* ☿ in 11° 4′ of the ſame Sign, you will have adorned your Globe with the Characters of the Seven Planets, all appearing in their proper Place as they are in the Heavens.

This is mighty entertaining, ſaid ſhe; here take this Pencil quickly, and let me ſee you juſt now place all your Planets upon the Globe according as they ought to be done, that I may learn how to range them another Time: For I fancy their very *Characters* or Figures ſo much, that I could almoſt wiſh our Patches were cut into ſuch pretty Form; but that I fear it will revive the fooliſh Notions of Aſtrology again, which you have taught me to diſpiſe. But pray, continued ſhe, how do you know the Planets from the fixed Stars when you ſee them in the Sky?

Pretty eaſily, ſaid I, Madam, as to *Saturn*, *Jupiter*, *Mars* and *Venus*. And *Mercury* is ſo near the Sun, as to be very rarely ſeen at all.

That puts me in mind, ſaid ſhe, of what Sir *Richard Blackmore* ſaith of him in his *Poem* called *Creation*, in theſe Lines:

Mercury, neareſt to the Central Sun,
Doth in his oval Orbit circling run;
But rarely is the Object of our Sight,
In Solar Glory ſunk, and more prevailing Light.

Well remembered, Madam, ſaid I. But to our preſent Point, the Knowledge of theſe Planets from the fixed Stars: The former, you muſt know, do not *twinkle* as the fixed Stars do; beſides they are always and all of them in or near this Line here called the *Ecliptic*: Which you may eaſily learn to trace out in the Heavens, by theſe Conſtellation which compoſe the Twelve Signs; and if you ſhould, at laſt, doubt about the *Planets*, if you ſee them change as they will do, in ſome Time, their Diſtance from any fixed Star that you know; you may eaſily diſtinguiſh them to be *Erratics*.

I think, ſaid ſhe, you reckoned ſeven Planets juſt now; ſure I have read ſomewhere, that there are more.

In that Account above, ſaid I, Madam, I followed only the vulgar way of Computation; for in Reality the Sun is no Planet or Wanderer, but a fixed Star placed in the Center of our Syſtem, and in all Probability like the reſt of thoſe that we ſee in the Heavens. And round him, as a Center, *Mercury*, *Venus*, *Mars*, the *Earth*, *Jupiter*, and *Saturn*, do revolve, and are now called *Primary* Planets; becauſe they revolve round the Sun, as their Center: While the others we call *Secondary Ones*, or *Satellites*, i. e. Guards or Attendants, becauſe they revolve round ſome one of the *Primary* Planets, as their Center, and together with it move alſo round the Sun.

Thus the Moon is a Secondary Planet, whoſe Center of Motion is our Earth, on which ſhe conſtantly attends, and her Circle round us ſhe performs in about a Month's Time, while at the ſame time ſhe revolves together with the Earth round the Sun in it's Annual Courſe. *Jupiter* hath four ſuch Moons or *Satellites*; and *Saturn* five, revolving round him: But it doth not yet appear that *Venus* or *Mars* have any *Satellites* at all.

As for *Mars*, ſaid the Lady, I ſhall not trouble my Head about him; though one would think, the God of War, or Captain-General of Heaven, might command a few Guards or Followers: But I will never forgive the Aſtronomers, nor believe at all in Teleſcopes, if they do not find out that *Venus* hath ſome *Attendants*; that is ſuch an Affront to our Sex, as we muſt never paſs by. But to be ſerious, I ſuppoſe, *Mercury* and *Venus* being ſo near the Sun, have no Occaſion to be lighted in the Night by Moons, as the more remote Planets have; though why our Earth ſhould have one, and yet *Mars* none, is not, methinks, ſo eaſy to be accounted for. But we have made a long Excurſion from our Globes; pray let us return to them: And let me ſee what I ſhall be the better for knowing how to *rectify* the Globes, and to *patch* on the Planets, as you juſt now have ſhewed me the way of.

Madam, ſaid I, bring the *Sun's Place*, for *May* 10, to the graduated Side of the Meridian, and then turn or ſet the *Index* of the Hour-Circle (placed here as you ſee upon the Braſs *Meridian* about the Pole) to Twelve at Noon; and then your Globe will be fitted to ſhew you the State of the Heavens. As it now ſtands, the Mark for the Sun repreſents his being on the

Meridian, as he is every Day at Noon; and there it will ſhew the Sun's *Meridian Altitude* above the South Part of the Horizon to be 58 *Deg.* 42 *Min.* Then if you will bring that Mark to the Eaſtern Edge of the Wooden Horizon, you will ſee there *what Point of the Compaſs* the Sun riſes upon, and your *Index* will ſhew you the Time of it; and if you bring the Sun's Place to the Weſtern Edge, you will find how far from the true Weſt Point the Sun ſets, and what o'Clock it is when he *goes down*, as we call it: Thus, *May* 10, the Sun riſes about $\frac{3}{4}$ of an Hour before Five o'Clock, and ſets $\frac{3}{4}$ of an Hour after Seven.

Well, ſaid ſhe, I fancy I ſhall be able to make an Almanac in a little Time.

That you may ſoon do, this way, ſaid I, Madam, and much better than moſt of thoſe who publiſh them: But if you have a mind to know the Stars and Planets, how they will appear, and are ſituated at any particular Time, ſuppoſe To-night at Eleven o'Clock; you need only turn the Globe about till your *Hour-Index* points to Eleven at Night; and then putting a little Piece of Paper under the Braſs Meridian, to ſtay the Globe in that Poſition, pleaſe to turn the Frame, and Globe and all about, till the North-Pole here points up towards the *Pole-ſtar* in the Heavens; and then you will have all you can wiſh for ſhewed you: for, by comparing the Pictures and Marks of the Stars and Planets with the real ones, at that Time in the Heavens, you will find them exactly to anſwer to one another; and *theſe* on the Globe will make *thoſe* eaſily and ſufficiently known to you.

Sir, ſaid ſhe, after abundance of Thanks, I muſt beg you to break off here; we muſt defer this till Night;

When with the Stars we'll be familar,
As e'er was Almanac Well-willer.

And in the mean Time, I will con my Leſſon in the Book, that my Ignorance may not give you too much Trouble. The Tea waits us; will you pleaſe to move, Sir?

The Evening of this Day proved one of the fineſt I ever ſaw, and the Night ſucceeding it was ſo very clear and bright, that the Moon being then not above our Horizon, there appeared many more Stars than uſual. As we were walking to a Summer-houſe, placed on a Mount in the Garden, where the Lady had ordered the Celeſtial Globe to be ſet out, ſeveral Poetical Deſcriptions of ſuch a Night occurred to our Thoughts, and were recited. The Lady cloſed all with that famous one of Mr. *Dryden:*

> All things are huſht, as Nature's ſelf lay dead,
> The Mountains ſeem to nod their drowſy Head,
> The little Birds in Dreams their Songs repeat,
> And ſleeping Flowers beneath the Night-dew ſweat:
> Even Luſt and Envy ſleep ———

I was going to ſay — *But Love denies*, &c. when ſhe interrupted me, and ſaid, I will have nothing of *Love* mentioned nor talked of To-night; the Opportunity is too ſolemn, and I am afraid I ſhall grow in earneſt and ſerious about it: We will both make our Court now only to *Urania*, and every *gay thing* ſhall give place to *Aſtronomy:* Let us enter the Summer-houſe, and ſee whether I have rectified the Globe as it ſhould be, and ſet it right to repreſent the preſent Time, which is juſt half an Hour paſt Ten.

Madam, ſaid I, you have done it with Accuracy: And I ſee you have mended the haſty clumſey Figures that I had made, of the Planets, and have placed very beautiful ones, of your own, in their Room.

But, ſaid ſhe, I do not know how to place the Globe due North and South, as my Book directs, unleſs there were a little Compaſs here, placed on the Frame.

Madam, ſaid I, there uſually is ſuch a Compaſs made on purpoſe to be placed on the Globe; but I can ſhew you how to ſet the Globe right enough without it; you ſee theſe ſeven large Stars here, that are painted within the Figure of the greater Bear, three in the Tail, and four in his Body: Theſe our *Engliſh* Country People call *Charles-Wain*, and fancy the *four* to be the four Wheels of the Waggon, while, forſooth, the *three* are to repreſent the three Horſes that draw it. But as to the preſent Concern, pleaſe to take Notice, that as this Conſtellation, in our Horizon, *never ſets*, but ſeems to revolve round the Pole in 24 Hours; ſo theſe two Stars of the ſeven, that are neareſt to the Pole-Star, or the two hinder Wheels of the Wain, do always *point* up pretty nearly to the Pole-Star; and are therefore ſometimes called the *Pointers*; and conſequently, if you carry your Eye on in a Right Line from them, they will direct you to the *Pole-Star*, which you ſee is here, on the Globe, placed in the End of the Tail of the *Leſſer Bear*, a Conſtellation of ſeven pretty large Stars, much in the ſame Figure of thoſe in the *Great Bear* or *Charles-Wain.*

I ſee them on the Globe, ſaid ſhe, let us now look out of the Window and obſerve them in the Heaven; O! I ſee them yonder very plain, ſaid ſhe, and now I ſhall know in the Night as well as Day, how to find the four Points of the Compaſs, *Eaſt*, *Weſt*, *North*, and *South*.

We muſt then return again to the Globe, Madam, ſaid I, and by opening the North Window, direct it's Pole to point up to the *Pole-Star*, and ſo ſet it as near as we can due* North and South.

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* Here the Braſs Meridian of the Globe was placed due *North* and *South*.

There is no need of great Accuracy for our preſent Purpoſe; and I think it ſtands pretty true now. Before we look or go out again, pray, Madam, pleaſe to obſerve this Situation of the Globe, and then you will eaſily ſee how the Poſition of the Stars do at preſent correſpond with it: There is, indeed, now not any very eminent Star, or one of the firſt Light or Magnitude, *exactly* on the Meridian, either North or South: But you will ſee this great Star, which is called the *Virgin's Spike*, becauſe painted on an Ear of Corn which ſhe holds in her Hand, a little to the Weſtward of the South, and about 28 Degrees high above the Horizon; as you ſee, appears by bringing this Quadrant of Altitude ſcrewed in the Zenith, to it; which is an Arch of 90°, and being moveable, ſerve to ſhew the Altitude of any Star or Planet.

I ſee that, ſaid the Lady, *here* on the Globe: But how ſhall I be able to find and count Degrees in the Heaven?

You know, Madam, ſaid I, that it hath been before obſerved to you, that the Aſtronomers have Inſtruments made on purpoſe for it, which do it with great Accuracy: But as for your preſent Enquiry, how high any Star or Planet appears to be above the Horizon, you may gueſs at it nearly, thus: The Diſtance you ſee here between the *two Pointers* of the *Great Bear* beforementioned, is nearly five Degrees; and this being a Diſtance always ready, and in view, will ſerve you very well to gueſs at the Height of any Star above the Horizon; or at the Diſtance of one of them from another; ſo as to enable you to find out any of them in the Heavens by the Help of the Globe, or any Planiſphere, or Map of the Heavens: Uſe will make this eaſy to you; and when you come alſo to conſider, that from the Zenith to the Horizon, being 90°, half that Diſtance muſt be 45°; one third of it 30°; a ſixth of it 15°; a ninth Part of it 10°, *&c.* you will, by Degrees, eaſily gain a practical Knowledge of theſe Diſtances.

But if you pleaſe we will go on: Almoſt South-weſt, at this Time, and about 43° high, will appear another Star of the firſt Magnitude, called *Deneb*, which is in the Tip of the Tail of the Lion: I ſee it yonder ſimpering through that Weſtern Window;

dow; if you will let me lift up the Saſh, you may ſee it without going out.

O! I do, ſaid ſhe, and the Virgin's Ear of Corn too, very plain: But what are thoſe two great Stars that appear together almoſt nearly Weſt, and let me ſee! — do not tell me —— about, about —— I muſt look out at the *Pointers* again to get my Meaſure —— why, they are about 25 Degrees high.

Very well gueſſed, ſaid I, Madam; you will come to meaſure the Diſtance of Stars by your Eye, in a little Time, as accurately as the good Houſewives and Work-women can meaſure Cloth or Ribbons, by the Length of their middle Finger.

Well, ſaid ſhe, Mr. *Obſervator*, and ſo I can too, for all I have a Mind to be an Aſtronomer, as well as the beſt of them; and I do not deſign, Sir, that my Studies ſhall ſpoil my Houſewifery: But pray tell me quickly, who thoſe two famous Stars are.

The uppermoſt, Madam, ſaid I, is called the *Lion's Heart*, and is, you ſee, drawn here on the Globe: And the other is *Jupiter*; you remember you have drawn the Character of him here your ſelf.

Bleſs me! ſaid ſhe, is that *Jupiter?* — well, I have many Queſtions to aſk you about that Planet another Time, but I will not ſtop you now; pray go on, and ſhew me how to know more of theſe Stars and Planets; for I begin to grow mighty fond of their Acquaintance.

Do not you ſee, Madam, ſaid I, here on the Globe, two Stars, about 15 or 16 Degrees high, and within two Points to the Weſtward of the Northern Edge of the Horizon? Theſe two are called the Shoulders of *Auriga*, and the lowermoſt and moſt Northern is called *Capella*, and is a Star of the firſt Magnitude; theſe are very conſpicuous Stars, and you may ſee them in the Heavens very plain out of that Northern Window.

I do, ſaid the Lady, very clearly, and I ſee, ſaid ſhe, alſo another pretty remarkable Star, about the ſame Height with *Capella*, about a Point to the Northward of the Weſt under the *Great Bear*; pray, What Name do you give him?

That is called *Pollux*, Madam, ſaid I, and his Brother *Caſtor*, you ſee, ſits here cloſe by him on the Globe; and between them they make up one of the Signs of the *Zodiac*, which they call *Gemini* or the Twins.

Is that, ſaid ſhe, the Deity that the Countrywomen ſwear by, when they cry O *Gemini!* —— But do not look grave, or give me any Return: For though I trifle, and am impertinent, I will not allow you to be ſo. Let us go on, and ſee what noble Stars we can find to the Eaſtward of our Meridian.

Madam, ſaid I, if you will look out at that North-Window, and direct your Eye along by the Pointers of the *Great-Bear*, till you ſee paſt, or beyond, the *Pole Star*, and continue it down till you come within 20 or 30 Degrees of the North North-Eaſt Part of the Horizon, you will ſee an eminent Conſtellation, which is called *Caſſio-*

pæia's Chair: This is the Figure of it here on the Globe; it is always oppoſite to the greater Bear, either above or below the *Pole-Star*.

I ſee it, ſaid ſhe, very plain, and a very notable Collection of Stars it is; but, pray, ſaid ſhe, what do you mean by calling it *Caſſiopæia's Chair?* Who, or what was that *Caſſiopæia?* ſure I have read ſomething about her, in ſome Books of the Heathen Gods.

No doubt of it, Madam, ſaid I, and the Company you will ſee ſhe is in, will refreſh your Memory. This *Caſſiopæia*, the Poets' tell you, was the Wife of *Cepheus*, who was, once upon a time, King of *Æthiopia*; and *here* the good old Monarch ſtands upon the Globe, with his Scepter in his Hand, juſt above *Caſſiopæia*; and below her, at the very Edge of the Horizon, you ſee, you are to look for her fair Daughter *Andromeda*, who had the Vanity to think herſelf handſomer than the *Nereides*, or Sea-Nymphs, which put them into ſuch a Rage, that they immediately applied to old *Neptune*, the God of the Sea, to revenge the Indignity.

On this, the obſequious Deity ſent a huge ugly Monſter up into the Country, which did great Miſchief there: The poor People, who in thoſe Days were always puniſhed for the Sins of the *Great Ones*, applied to the Oracle for Relief, and were told that the only Way to appeaſe the Gods, who were all on the Side of the *Nereides*, was, to expoſe the audacious *Andromeda* to be devoured by a Sea-Monſter; which I ſuppoſe *Neptune* undertook to get ready for that Purpoſe. This was done, but the gallant *Perſeus*, whom you ſee here on the Globe, juſt behind her, as her Champion, delivered her and killed the Monſter, and I hope carried off the Lady; and to reward the Mother of ſo beautiful a Creature, he got *Jupiter* to *place her* up here among the Stars, and they form the Celeſtial Chair in which ſhe ſits in State: And thus, Madam, I have given you the Hiſtory of one of the Conſtellations, and if you pleaſe, I can tell you as *long* and as *true* a Story of many of the reſt.

I thank you, Sir, ſaid ſhe, but you ſhall not, this is enough for a Sample; and now I remember all this Stuff about *Perſeus* and *Andromeda*, as well as if I had ſeen the whole Affair, as I believe I did once, or at leaſt good Part of it, ſhewn upon the Stage: And have much oftener ſeen it in Pictures and Prints. But dropping all Fables, let me go on with my Leſſon; I ſhall know *Caſſiopæia* again, whenever I ſee her.

But, ſaid I, Madam, I have a Story to tell you of *Caſſiopæia*'s Chair, that is no Fable, but a certain Truth, and yet is equally ſtrange with the other fabulous Relation. About the Year 1572, there appeared a *New Star* in this Conſtellation, which at firſt was as big as *Jupiter* appears now to be, and was fixed to one Place like the reſt of the fixed Stars; but leſſened by Degrees, and at laſt, at the End of 18 Months, went quite out, and appeared no more.

That, indeed, is a very unaccountable thing, ſaid the Lady; but as I have met with ſome ſuch Relations of other fixed

Stars, ſo I ſhall leave my Surprize, and my Queries about it; till I come to trouble you about the Nature, Uſes, and Diſtances of the fixed Stars in general for I muſt have a deal of Talk with you about *that* and other Things in Aſtronomy, before you get quite rid of me, and you muſt thank yourſelf, if my Curioſity be teazing and impertinent; for you have wound it up to a very great Height, I will aſſure you. But, pray, Sir, let us now go on and make an end of our Stars; it grows late and the Air cold.

Madam, ſaid I, we ſhall diſpatch the reſt, as faſt as you pleaſe, for the Way I have ſhewn you, of finding and diſtinguiſhing the Stars above-mentioned, will teach you to do ſo, by any others in the Heavens: Thus you will ſee here above the Pole-Star, and about 14 Degrees from him, and a little to the Eaſtward of the Meridian, the Conſtellation, called the *Little Bear*, conſiſting alſo of ſeven pretty eminent Stars, of which the lowermoſt, *now*, or that in the Tip of his Tail, is the *Pole-Star:* You ſee here, almoſt due Eaſt, a fine bright Star of the firſt Magnitude, which is called *Lucida Lyra*; and under it, a little to the South of the Eaſt, as *Lyra* is to the North, another great Star of the firſt Light, about 12 Degrees high, which is called *Alcair*: And you cannot but take notice of theſe four Stars here, all of the ſecond Magnitude, placed in the Form of a Lozenge, which is called the *Dolphin*. About 8 Degrees high, and about 2 Points and ½ to the Eaſtward of the South, you ſee alſo a famous Star, of the firſt Light, in the Body of *Scorpio*, one of the 12 Signs.

All theſe Stars I ſee, ſaid the Lady, and I think diſtinguiſh very well; and I fancy I ſhall be able, by Degrees, by the Help of ſuch eminent Stars as *that*, which I ſee here on the Globe, are placed pretty near the *Ecliptic*, to *trace out*, as you ſaid a while ago, that Circle in the Heavens. But, pray, firſt tell me, what you call that Star, or rather Planet, (for I fancy it is one of thoſe *wandering* Lights) which appears yonder, almoſt upon the South Part of the *Meridian*, and about 25 Degrees high.

You have gueſſed very right, Madam, ſaid I, it is a Planet, and the moſt remote one of all, *Saturn*.

Is that *Saturn?* ſaid ſhe; I am heartily glad to ſee him, I ſhall know him again another time; I long to peep at him through a Teleſcope, and to ſee his famous *Ring:* But of this, more ſome other Time, when the Teleſcope, you have promiſed me, is fitted up. Is there any thing elſe worth obſerving, before we remove to our Sleep?

Only pleaſe, Madam, ſaid I, to take Notice of that *Track of Light*, yonder in the Heavens, and here drawn upon the Globe, which is called the *Milky Way*. You ſee here by the Globe, as the Poſition of the Heavens is now, that it begins at the North Part of the Horizon, about *Perſeus*, takes in *Caſſiopæia*, and after that the *Swan*, and then runs on towards *Scorpio*, and towards the *South Pole*, and takes in the famous Conſtellation called the *Croſs*; then it turns *Northward* again, through the *Ship*, a little above the *Great Dog-Star*, or *Syrius*, and above the Right Shoulder of *Orion*, and thence taking in *Capella*, runs on towards *Perſeus*, where we began to trace it.

I am glad you thought to ſhew me this, ſaid ſhe, before we finiſh our Night's Obſervations; I ſee it plain in the Sky, and perceive that it's Figure, on the Globe, correſponds exactly with it: I will not ſtay now to aſk you what it is, becauſe that may be one of my many Queſtions to you another time; we will only remember what Mr. *Milton* ſaith of it:

A broad and ample Road! whoſe Duſt is Gold,
And Pavement Stars, as Stars to us appear,
Seen in the Galaxy, that Milky Way,
Like to a circling Zone powder'd with Stars.

Mr. *Milton*, Madam, ſaid I, alludes to the Notion that the Poets had of it; that it was the Path which the Gods uſed in the Heavens, which Mr. *Dryden*, from *Ovid*, thus alſo deſcribes:

A Way there is in Heaven's extended Plain,
Which when the Skies are clear, is ſeen below,
And Mortals, by the Name of *Milky*, know:
The Groundwork is of Stars; thro' which the Road,
Lies open to great *Jupiter*'s Abode.

Sir, ſaid the Lady, a Thouſand Thanks to you for the Pains you have taken to inſtruct me, and I wiſh you a good Repoſe.

The next Day my Affairs called me away, for ſome time; but at my Return, as I found the Teleſcopes and other Inſtruments I had ſent for, in perfect good Order, ſo I found the Lady had been cloſe at her Aſtronomical Studies: She was exactly ready in all Problems upon either Globe, and had gotten ſuch an intimate Knowledge of the Stars, that ſhe had alſo acquired a very tolerable Knowledge in the ſeveral *Syſtems* of the Univerſe, or *Hypotheſes* to ſolve the Celeſtial Appearances, as they are called by Aſtronomers; and longed with great Impatience to ſee the Uſe of the *Teleſcopes* and *Quadrant*, &c. which I had ſent down to her Country-Seat.

Where, ſoon after I arrived, ſhe put me upon beginning our Obſervations and had mothodized the Enquiries and Queſtions ſhe deſigned to make, with great Addreſs and Dexterity.

Let us begin, ſaid ſhe, to talk a little about the *Sun:* I think you agree, that his Center appears to move always in the ſame Line, or in the *Ecliptic*; but I think you ſay his apparent Motion is *unequal* there.

It is true, ſaid I, Madam, for when the Earth is *neareſt* the Sun, as ſhe is in Winter, then ſhe in *reality*, and the Sun, *ſeemingly*, moves *faſter* than in the Summer, when the Diſtance between the Earth and the Sun is greater; and accordingly the Sun's Diameter appears *bigger* in Winter than in Summer.

But, Sir, it is ſtrange, methinks, ſaid ſhe, that the Sun's *nearer Approach* to us in Winter than in Summer, doth not counterchange thoſe Seaſons: Have not we the greateſt Heat from the Sun when we are neareſt to him?

No, Madam, ſaid I, for the different Heat of our Seaſons of the Year, do not depend upon *that*, but upon the Sun's Rays falling more *directly*, or more *obliquely* upon us; together with the length of his ſtay above the Horizon, which is a great deal longer every Day in Summer than in Winter: For in the Diſtance of 70,000,000 of Miles, a little Approach of the Earth to, or it's Receſs from, the Sun, will make no ſenſible Alteration as to Heat or Cold. But there is another thing ariſing from this Inequality in the Earth's Motion round the Sun, which is pretty conſiderable, and that is, that the Sun will appear to tarry about 8 Days longer in the Northern Part of the Ecliptic than he doth in the Southern; the Reaſon of which is, from the Figure of the Earth's oval or eliptic Orbit *: And thus having given you ſome general Ideas of theſe Things, I wait your further Commands.

Why then, ſaid the Lady, pray give me now, for it ſeems to be a proper Place, ſome little Knowledge about the *Equation of Time*, which I have read a good deal about, and Tables of which I have ſeen hanging by Clocks, and put upon Dials and Watches; pray, can our Sun be in the wrong, does not he meaſure Time equally?

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* See *Lex. Techn.* Vol. II. under *Sun.*

Madam, ſaid I, the daily Revolutions of the *Earth*'s Equator round it's Axis, are exactly equal in Time to one another; and yet the Time from the apparent Noon of one Day to that of the next, is unequal, and ſometimes greater, and ſometimes leſſer.

Well, ſaid ſhe, I am glad however, it is not our Earth's Fault, and that ſhe is ſo regular in her diurnal Whirls: But pray let me then know, where the Error, or Inequality, lies?

There is, ſaid I, Madam, a double Cauſe of this Inequality; the former is, that the Earth's Annual Orbit is not an *Exact Circle*; and the other is, that the Earth's *Equator*, about which the Diurnal Motion is made, and the *Ecliptic*, or the Circle ſhe deſcribes round the Sun, are not *co-incident*, or in one and the *ſame Place*, but make an Angle, as you know they do, at their Interſection, of 23° 30′ of which, when your Curioſity, and further Knowledge of theſe Affairs, leads you to make more full Enquiries, you will receive a plain and ſatisfactory Account, from Mr. *Whiſton*'s Aſtronomy, p. 116, 117, *&c.*

I thank you, Sir, ſaid ſhe, but pray let us now get all things ready to look on the Sun with your Glaſſes, that I may know, by my Eyes, as much as I can of that wonderful Luminary, the great Center of all the Planets' Motions.

Our Teleſcope was about 14 Foot long, and had a plain Glaſs ſmoaked with a Candle, ſcrewed on before the Eye-Glaſs, to defend the Eye from receiving any Injury from the too intenſe Light of the Sun.

After ſhe had looked upon him two or three Times; it appears plainly, ſaid ſhe, to be a great Globe of Fire, or rather, as *Butler* ſaith,

——————————— *A Piece*
Of red-hot Iron, as big as Greece.

and ſo no doubt it muſt be, by the great and conſtant Heat which it gives: But, pray, tell me, as fully as you can, what the late Aſtronomers and Philoſophers have diſcovered about this vaſt World of Light. I perceive you ſuppoſe him fixed and immoveable, as to Place, in the Center of what you call the *Solar Syſtem* ; but doth he turn round his own Axis or not? how much bigger is he than our Earth? how far is he from us? and how can his Heat continue ſo long as it hath done, without any ſenſible Waſte or Diminution?

Madam, ſaid I, by obſerving carefully the Spots, which often appear in the Sun's Face, though there happen to be none now, they have diſcovered that the Sun revolves round it's own Axis, in about 25 Days.

Spots! ſaid ſhe, What, are there *Spots* in the Sun, which ſometimes appear there, and ſometimes not; for God's Sake what are thoſe *Spots?*

There are various Opinions about them, Madam, ſaid I; but the moſt probable one, is, that they are a Kind of Droſs or Scum, which ſometimes gathers upon his Face, as is the Caſe of melted Metals; for I have ſeen ſeveral *Spots*, which for a Time appeared ed diſtinct, at laſt ſome of them quite vaniſhed, and others run together into one, and ſo compoſed a much greater Spot, as was the Caſe at the Time of the laſt famous Eclipſe of the Sun; and ſome of theſe Spots muſt be immenſely large, to appear ſo big as they do, ſometimes, to us, conſidering the prodigious Diſtance of the Sun, which probably amounts to about 70 or 80 Millions of Miles.

Eighty Millions of Miles! ſaid ſhe, Why you fright me, my Head turns round, and I am giddy with the very Notion of it!

And yet, Madam, ſaid I, as great as this Diſtance is, a Ray of Light runs it in about ſeven or eight Minutes Time; while ſuch a ſwift Traveller, as a Cannon-Ball, ſuppoſing it to move all the Way as faſt as when it juſt parts from the Gun, cannot arrive there in 25 Years. Theſe things muſt needs appear wonderful and ſurprizing to you, but we have *very good Reaſons* to conclude, that they are very near to Truth; *which* I forbear to mention, becauſe perhaps at preſent, you may not be qualified fully to comprehend them.

I doubt, indeed, I am not, ſaid ſhe, which I heartily lament, and I envy you Men and Scholars, as much as I dare, the Pleaſure of knowing the Reaſons of, and inquiring into, the Natures of theſe amazing Things. But, pray, Sir, is not the Bigneſs of the Sun anſwerable to this vaſt Diſtance that he is from us?

Yes, Madam, ſaid I, according to theſe Ways of Computation, the Sun's Diameter, or his Breadth from one Side to the other, is about 800,000 Miles, which is above 100,000 times greater than the Diameter of our Earth; and therefore his Bulk, or rather the Quantity of Matter in the Sun, muſt exceed that of the Earth, above 10,000,000 Times.

And this Conſideration of the Vaſtneſs of the Sun's Magnitude will account for the Query you rightly enough ſtarted, how he can ſo long continue his Heat without any ſenſible Diminution? For we take the Sun and the fixed Stars to be only very great Bodies of Earth, vehemently hot, whoſe Heat is preſerved by their Greatneſs, and by the mutual Action and Re-action between them and the Light which they emit, and whoſe Parts are kept from burning out and fuming away, not only by their being of a fixed Nature; but alſo by the Weight and Thickneſs of the *Atmoſpheres* which are round about them, and which do ſtrongly compreſs them, and condenſe the Vapours and Exhalations which would otherwiſe fly away from them; but are now by this Means made to fall back again upon his Body. And as to the daily Expence of his Light and Heat, the Particles of Light are ſo infinitely ſmall, that out of a Body ſo big as the Sun, they may be ſent for many hundred thouſands of Years together, without any ſenſible leſſening of his Bulk, Weight, or Magnitude.

I believe I comprehend the main of your Reaſoning, ſaid ſhe, but I am got a little out of my Depth; let me recover firm Ground again, and then I would aſk you farther, whether, ſince you take the Sun to be an immenſe Globe of Earth, thus ſet on fire, and the fixed Stars to be Suns, or Bodies of the ſame Nature, you do not think the Stars, ſeverally, to have the ſame Uſe, and to be the *Centers* each of them, of *Syſtems of Planets* revolving round them, as ours do round the Sun, to whom they afford ſuch all-chearing Light, and enlivening Heat as our Sun doth to us? For methinks it is a mean Uſe of them, and below the Wiſdom of our *Great Creator*, to place them in the Sky only to twinkle and divert us; whereas, all of them put together, do not afford us the 10th Part of the Light of the Moon; but if we ſuppoſe them all to be Suns to ſome *other Syſtems* of Planets, becauſe of their vaſt Magnitudes, and becauſe of their ſhining, as I think you agree they do, by their own Light, and not with one borrowed, like that of the Planets; what a glorious Idea doth it give us of the Almighty Power! of the Wiſdom and Goodneſs of the Divine Nature? And what a poor contemptible Opinion ought it to make us entertain of ourſelves, who perhaps may bear as little a Proportion in *Wiſdom* and *Knowledge*, to ſome of the Beings that inhabit the Starry Regions, as we do in *Magnitude* to them all; for I can eaſily conceive infinite Degrees of Knowledge and Perfection, with as great a Variety, that may be in a *Series* in Creatures between us and the Deity; and perhaps there may be alſo a conſiderable one below us.

I agree intirely with you in that Speculation, Madam, ſaid I, but we muſt touch it tenderly, or elſe the old Divines will be angry.

Ay, ſaid ſhe, ſuch of them as imagine all Things made for the ſake of *Man* only; but I have no ſuch lofty Notions of the Dignity of our Species; and I think Mr. *Oldham*'s is a very juſt Satyr upon that narrow Notion, when, with regard to the very Point before us, he ſaith, that Man believes,

That turn-ſpit Angels tread the Spheres for him.

But now I am talking about the Stars, pray tell me once for all, have theſe Stars and the Planets no real Influence upon us Mortals?

Not at all, Madam, ſaid I, ſo as by any Phyſical Power to influence our Wills, Lives, and Actions; that kind of Effect is certainly more true with regard to what the Stars have often been *unequally compared*, the Eyes of a fine Lady of good Senſe and Virtue; for *thoſe* do certainly, like the *Eyes of a good Magiſtrate*, *ſcatter* and diſperſe all Evil before them: They heighten our Genius, and inſpire us with Wit, and yet keep our Converſation as chaſte and modeſt as they make it entertaining and inſtructive.

I always take your Compliments for *Inſtructions*, ſaid ſhe, and have no Excuſe to make for the Vanity of being pleaſed with them, but that I will endeavour to be as good as you repreſent us, and we ſhall have a much better Reaſon than ever to value the Power we may have over your Sex, if we can make it help us to reform it: But you will not allow me then to believe any Aſtrologic Influences?

Not any at all, ſaid I, Madam, for they ſerve only to nurſe Superſtition, to fill us with falſe Fears, deceive us with vain Hopes, and to excite a dangerous Curioſity, and an unreaſonable Inquiſitiveneſs into Futurities; and it is indeed, in effect, either making the Stars ſo many Deities, and conſequently running into ſome of the worſt Sorts of the Idolatry of the Heathens; or elſe it is introducing the Notions of a Phyſical Fatality, and baniſhing out of our Minds all Religious and Moral Notions.

Sir, ſaid ſhe, I acquieſce; and to tell you the Truth, I never had much Faith in things of that Nature: But let us leave this Sun of ours for the preſent;

This Sun of our poor World both Eye and Soul:
This Sun, that with ſurpaſſing Glory crown'd,
Looks from his ſole Dominion like a God;
That by magnetic Beams thus gently warms
The Univerſe, and to each inward Part,
With gentle Penetration, tho' unſeen,
Shoots genial Virtue even to the Deep:

As I think *Milton* expreſſes it; and give me leave to aſk you a few Queſtions about his *Brethren, the Stars.* If the Sun and they be nearly of the *ſame Bigneſs*, as they appear to be of the *ſame Nature*, what an infinite Diſtance muſt they be from us?

It is very juſtly obſerved, Madam, ſaid I; for indeed, whatever their Bigneſs be (and much leſs than the Sun we have no reaſon to ſuppoſe any one of them to be) their *Diſtance* is ſo great, that the Diameter of the Earth's yearly Orbit or Circle round the Sun, which you know muſt be double to his Diſtance from us, and therefore, about 160 Millions of Miles: This, I ſay, according to all the Obſervations we can make, and the Reaſonings we can form, bears no manner of Proportion, and is but a Point, in compariſon of the Diſtance of the *neareſt fixed Star*; for we have no reaſon to ſuppoſe them *all equally remote* from us. And could we advance towards theſe Stars 99 Parts in 100 of the whole Diſtance, and that there were but one hundredth Part of the preſent Diſtance remaining, they would appear very little larger to us than they do now. The Diſtance of *Syrius* or the *Dog-Star*, Mr. *Huygens* takes to be about 27,000 times as far from us as the Sun is; ſo that I believe we are not much out of our Computation, when we conclude, that a Ray of Light cannot come from thence in leſs than ſix Months time, nor the Cannon-Ball, abovementioned, in 50,000 Years.

Good God! cried ſhe, how immenſe and wonderful are the Works of thy Hands! Why then, ſaid ſhe, if all the Stars were to be extinct or annihilated this next Night, we ſhould not miſs them till about ſix Months after!

No, Madam, ſaid I; that Stream of Light now flowing from them to our Eyes, ſhould the Fountain be ſtopped, would be half a Year before it would be run quite out; though it run after the rate of above 10 Millions of Miles in a Minute; a Motion almoſt as quick as Thought itſelf, as we uſually ſay.

Well, ſaid ſhe, this hath made an extravagant Notion of Mr. *Whiſton*'s, * about the Diſtance of *Heaven*, or the Region appointed for the Bodies of the Bleſſed, it's not being by any Means ſo far off as the ſuppoſed *Empiræan Heaven* of the Divines, much eaſier to me than it at firſt appeared; and which then I thought a very new, wild, and unaccountable Opinion. But, pray, let us go on; Is not the *Number* of theſe fixed Stars as wonderful as their *Diſtance?*

Yes, in truth is it, Madam, ſaid I; for as the naked Eye diſcovers immenſe

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* Vid. Account of S. S. Prophecies, p. 288.

Numbers of them in a clear Night, (above 1000 of which are diſtinguiſhed and taken notice of) and many more in the Northern cold Countries than we can do here; ſo when aſſiſted by a Teleſcope of any great Length, it ſees amazing Crouds of other Stars, which, becauſe they are inviſible without theſe Helps, the Aſtronomers have called very properly *Teleſcopical Stars.* Such a Glaſs as this which we but now uſed to obſerve the Sun with, will diſcover to you many Thouſands of Stars, before inviſible to the naked Eye; and I think I have told above Seventy within that little *Bunch of Stars*, which we call the *Pleiades*, or the *Seven Stars*; though now there appear but ſix to the bare Eye. The *Milky Way* is crouded with infinite Numbers of ſmall Stars, from whence, as is uſually thought, it's *Whiteneſs* appears; which is a Diſcovery entirely owing to the Teleſcope; but whether the Whiteneſs proceeds from the *Smallneſs* of thoſe numberleſs Stars, their *Nearneſs* to one another, or their *immenſe Diſtances*, we cannot yet certainly determine, but muſt leave to Time and future Obſervations.

How endleſs is the Extent of the Divine Power and Goodneſs, ſaid ſhe, and how far are we yet from knowing the Bounds of the Starry World? But, Sir, your hinting, that formerly there were ſeven when now there appear but ſix Stars in the *Pleiades*, reminds me of your Promiſe, to acquaint me with the Hiſtory of ſome Appearances of *New Stars*, and Diſappearance of others, in *Caſſiopæia's Chair*, and in ſome other Places in the Heavens.

Madam, ſaid I, the *Milky Way*, in which *Caſſiopæia* is placed, hath been famous for theſe Appearances; many new Stars having been diſcovered in the *Swan*, *Andromeda*, the *Ship*, *Eridanus*, and other Conſtellations within that Tract: Some of which have, after ſome Time, diſappeared, and then re-appeared again. Of theſe Things you may ſee ſeveral Inſtances collected by the Author of *Lexicon Technicum*, (a Book which your Ladyſhip hath) under the Title of *Fixed Stars*, in the ſecond Volume. But it is difficult to determine what theſe new Stars are; ſome fancy them to be Planets revolving round ſome of the Stars in the *Galaxy*, and which therefore become viſible only in that Part of their Circle which is next to us; others take them to be Comets, and others think that they are really *fixed Stars*, whoſe Light and Vapours expire, but are again recruited and enkindled by the Acceſs of Comets towards them: But theſe *Hypotheſes* cannot well ſolve all the Phænomena; for beſides the Appearances of theſe *New Stars*, it hath been obſerved of the known fixed Stars themſelves, that ſome of them have much changed their Magnitude and their Light; ſome of them have quite diſappeared for a Time, and then come into Sight again; and this at certain Times and determined Intervals. And when you come to read what Mr. *Huygens* obſerved of the Stars in *Orion's Sword*, you will meet with what will very much, and I believe very agreeably, ſurprize you; but let it be which Way it will, it is a wonderful *Phænomenon*, and perhaps will never be thoroughly known, if ever, till future Ages have increaſed our Obſervations, and improved our Reaſonings upon them.

I think, ſaid the Lady, I have enough for this Time, about the Sun and the fixed Stars; I will conſider of it, and have Recourſe to the Books you recommend to me, and trouble you the next Time about the Planets, in the Order as they are in, with reſpect to the Sun; only give me Leave to break in upon it, with regard to our own Planet, the *Earth*, and her Attendant, the *Moon*. With which, out of Self-Love, or rather Inclination to the Place of our Birth and Abode, I would fain begin, if you do not judge it to be improper.

By no Means, Madam, ſaid I; for many Things will occur in our Diſcourſes about the Moon and Earth, which are very common and obvious Appearances, and which thoroughly accounted for, and explained, will render the Knowledge of the other Planets much more eaſy, and intelligible.

Not long after this, the curious Lady attacked me again thus: I have been conſidering, ſaid ſhe, the amazing Subject we diſcourſed upon the laſt Time, and am prepared now to talk with you about the *Earth* and the *Moon*, and the different Magnitudes, and the Motions of each; and of this I find it previouſly neceſſary to have ſome Knowledge, or elſe my Enquiries into *thoſe* of the other Planets, will not give me ſufficient Satisfaction: Pray, Sir, how many Miles is the Diamter of our Earth reputed to be, by the Aſtronomers?

Something leſs than 8000, Madam, ſaid I; and becauſe I know you will expect it, I muſt tell you, that we attain this Diſcovery thus: Both in *England* and in *France*, a Meaſure in Length hath been taken upon the Earth's Surface, under one and the ſame Meridian, or, in a right Line running exactly North and South, till by accurate Inſtruments it was found, that the *Pole* was *raiſed* or *depreſſed* exactly one Degree. This, the Mathematicians of both Nations agreed in to be almoſt 70 Miles, *Engliſh*: And there being 360 Degrees in every Meridian, that Number, multiplied by the former, gives you the Number of Miles in the whole Circumference of a great Circle on the Earth, or how many Miles it is round our Globe; and then, by the Principles of Geometry, they know, that ſomething more than one Third of that muſt be the Earth's Diameter. I do not trouble you, Madam, with the exact

Numbers, nor the Multiplication and Diviſion, but you may depend upon it, that the round Number of 8000 Miles, is pretty nearly the Earth's Diameter, though ſomething too much: And the half of this, *viz.* 4000 Miles, is the *Semidiameter*, or the Diſtance from the Surface to the Earth's Centre, a Number, or Meaſure, much uſed by Aſtronomers.

I thank you, Sir, quoth ſhe, for this; the Knowledge of this ſingle Point, will, I ſee, carry me a great Way, when I come to read Aſtronomical Authors: But, pray, Sir, go on, and oblige me with a further Account of this Earth: Do you think it really turns round it's *Axis*, as you have found the Sun to do by it's *Spots?*

Yes, Madam, ſaid I, and as there is nothing more eaſy and ſimple than this Motion, ſo it accounts for the Appearances of Day and Night in an eaſy and natural Manner; for as this Earth revolves from Weſt to Eaſt in exactly 24 Hours Time, it makes the Sun *appear* to do ſo from Eaſt to Weſt in the ſame Time; and makes it *Day* to thoſe Places on it's Surface, which are turned towards the Sun, and

Night to ſuch as are in the oppoſite Parts; as you ſee Madam, if I ſet this Globe into the Sun's Light, it will illuminate *but one Half* of it, and the *other Half* will lie in the Shadow; but as I turn the Globe round it's Axis, all Parts of the Earth's Surface painted upon it, will come ſucceſſively into the *Light*, as the oppoſite Parts go, after the ſame Manner, into the *Dark*.

I grant you, Sir, ſaid ſhe, this is a very natural and eaſy Way of accounting for the Viciſſitudes of Day and Night; and ſo ſhort and unembarraſſed in compariſon of the other wild Notion, which makes the Sun, and all the Region of the fixed Stars, to revolve round us in 24 Hours, that it recommends itſelf to us at firſt Sight, as agreeable to the other Proceedings of Nature, if we could but get rid of our Prejudices, ſo as to conceive it poſſible to be done, without our perceiving it. But can we travel above 1000 Miles in an Hour, and not be ſenſible of it?

As eaſily as 10 in a Ship, Madam, ſaid I; where, let the Veſſel move never ſo faſt forwards, if it were not for the

Toſſings and Shocks which the Reſiſtance of the Water and Waves make, and for the Ruſtling and Buſtle that the Wind makes in the Sails, you would perceive no Motion at all in the Ship, but judge it to be perfectly at Reſt; and if another Ship lay at Anchor by you, you would judge that to move *backwards*, and not your ſelf *forwards*. And much more will this appear plain, if you conſider that with the Earth's Motion round it's Axis, the Air, and all the Atmoſphere moves along with you, and doth not reſiſt you, as is the Caſe in the Motion of a Ship. But indeed, the greateſt Wonder in this Caſe is, that we are not all whirl'd off into the Air, like Dirt from a Wheel, or Drops of Water from a twirling Mop, or Stones parting from a Sling.

Your talking of the *Twirl of a Mop*, ſaid ſhe, puts me in Mind of a whimſical Deſcription of *that Action*, which a Friend of yours made to ridicule ſome *Verboſe Verſes* then repeated: But though I have almoſt forgot them, I hope you have not.

Madam, ſaid I, your Ladyſhip's thinking of them now is proper enough; for though made to *expoſe* another Matter, they will *illuſtrate* what we are upon:

See how *Culina* with hard adverſe Wriſts,
The dreary Radii of her *Mop* untwiſt;
Swift twirling round, the *oblong Planet* rolls,
With Axe produc'd thro' the Meridian Poles;
The ſtiff'ning Threads their rigid Form preſerve,
While dirty Drops fly off in Tangents to the Curve.

Why this is very true, ſaid ſhe, of thoſe dirty Drops, and I cannot imagine why it is not ſo with us; for I do not know any thing that faſtens us down to the Earth, but our firm Inclinations to this World, which I believe hath yet no Phyſical Power to keep our Bodies annexed to it's Surface. Pray how do you account for this Difficulty?

By that Will of the Creator, Madam, which we call the *Law of Gravity*, or *Gravitation*; whereby all heavy Bodies have a Tendency towards the Center of our Earth, in ſuch an Over-Proportion, that the *Centripetal Force*, by which Bodies tend thither, is almoſt 300 Times greater, than that by which they are forced off by the Earth's Motion round it's *Axis*, or the *Centrifugal Force*, as they call it; and it is this *All-wiſe Proviſion* that keeps all Things together on the Surface of the Earth; and which, when exactly adjuſted, keeps alſo every Planet in it's proper Circle, and at it's due Diſtance from the Sun, or from it's Primary one: And this is ſo univerſal a Law, that it prevails every where. And if a Cannon-Ball could be diſcharged from any conſiderable Height, in the Air, parallel to our Horizon, and with a Velocity equal to that of the Earth's Attraction, or the Force of Gravity towards the Earth's Center, it would then neither *fall* to the Earth at all, nor go quite *off* from it, but would *revolve round* it, like our Moon; and this is the very Reaſon why ſhe doth ſo.

Well, ſaid ſhe, a new World of Knowledge opens and dawns upon me! I begin to ſee a thouſand Things, of which I had no Notion before; and I believe the Motions of the Heavenly Bodies, after this, will not appear ſuch abſtruſe unintelligible Things as I imagined them to be: But, pray, Sir, explain this a little further, with regard to the Moon.

You muſt know, Madam, ſaid I, that this Gravitation of a Planet towards any Central Body, decreaſes as the Square of the Diſtance from that Center increaſes; therefore the Moon being about 60 of the Earth's *Semidiameters*, or 240000 Miles diſtant from us; her Gravitation towards the Earth, will be 3600 Times leſs than that of a Cannon-Ball ſhot out of a Gun on or near the Surface of our Globe; for the Moon's Diſtance from the Earth, 60 of the *Earth's Semidiameters* being *ſquared*, that is, multiplied by itſelf, makes 3600; and if ſhe were but two Semidiameters removed from the Earth, the Square of 2 is 4, and as much as 3600 exceeds 4, ſo much does the Attraction of the Earth, or any Central Body exceed at 2 Semidiameters above that of it's Attraction at 60 Semidiameters. And the Great Creator hath ſo wonderfully contrived it, that her *Centrifugal* Force, or her Endeavour to fly off from the Earth, is exactly equal to her Gravitation thither; and this keeps her in her Orbit, as it doth all the Planets in theirs, as I ſaid before.

O wonderful and happy Adjuſtment! ſaid ſhe; for I perceive, if the Moon's Gravity towards the Earth were much abated, ſhe would run out of her Orbit, and leave us; and if the oppoſite Force were much leſſened, ſhe would in a little Time, tumble down upon us: Am I right, Sir, in this Concluſion?

Exactly, Madam, ſaid I, and I perceive I need not ſay much more to you upon this Head, except it be to tell you, that if the Centrifrugal Force were taken away from the Planets, and that only the Power of Gravitation towards the Sun remained, they would all ſoon fall down to him, and our Earth would get down thither in about 64 Days and 10 Hours Time.

But I think, Madam, we are gotten to the Moon a little too ſoon, having not yet quite done with the Earth, whoſe Annual Motion round the Sun therefore let us next conſider: By which all Increaſe and Decreaſe of Day and Night, and the *Changes* and *Seaſons* of the Year are made.

And can you give me any good Reaſons, that I can underſtand, to believe this Annual Motion of the Earth, ſaid ſhe?

I think, Madam, ſaid I, there is in Aſtronomy a *plain Demonſtration* for the Motion of the Earth round the Sun; but it will be too remote for your preſent Knowledge of theſe Matters: However, I think it is a very *good Argument* for it's being ſo, that *this way* there is a Parity and Agreement with the other Proceedings of Nature, which is very ſuitable to the Wiſdom, Eaſineſs and Conciſeneſs obſerved by the Divine Being: For it being now agreed, that the Sun is the Center of all the other primary Planets, and that we are placed in ſuch a due Diſtance from the Sun, between the Orbits of *Venus* and *Mars*, as anſwers to the *Time* of thoſe Planets' Revolution round the Sun; and ſince it is alſo agreed, that the *other primary Planets*, as well as *Mars*, *Venus*, and *Mercury*, do, in their ſeveral Orbits, revolve round the Sun; what Reaſon can poſſibly be aſſigned, why the *Earth* ſhould not do ſo too? ſince *they are Earths* likewiſe, as our *Planet* and the *Moon* are, and conſequently our

Earth muſt be as capable of moving round the Sun, or any other Center, as *they* or *ſhe* are.

I own, ſaid ſhe, that it is much more natural, orderly, and harmonious to ſuppoſe it ſo; and therefore I will lay aſide all Prejudice, and believe it with a good Aſtronomical Faith.

Madam, ſaid I, if you will obſerve what *Fontenelle* ſaith, very juſtly, of Nature, that *She is always magnificent in the Deſign, but frugal in the Execution of it*, you will never believe that the Sun and fixed Stars turn all round us in 24 Hours; when you reflect, that the bare Motion of the Earth round it's Axis will anſwer all your Ends that are to be ſerved by the other. That would be juſt as abſurd, as for a great Architect to contrive, with vaſt Expence and Machinery, a *Kitchen-Grate* that ſhould revolve round a Spit, in order to roaſt a *Wheatear*, or a *Wren*; but never ſo much as dream of a way to turn the Spit round.

It is monſtrous, ſaid ſhe, as well as ridiculous, and, as I told you before, I will not believe one Word about it: I ſee, that the more *plain* and intelligible Things are, the more they are valuable; and that *Obſcurity* and *Myſtery* are uſually the Effects of Ignorance, and want of Skill either in the Operator, or the Explainer. But, Sir, will you give me leave then to ſtep to the *Moon*, and aſk you a few Queſtions about her, for I cannot put thoſe fine Lines of *Butler* out of my Head:

The Moon put off her *Veil* of Light,
Which hides her Face by Day from Sight;
Myſterious Veil of *Brightneſs* made,
That's both her *Luſtre* and her *Shade*;
And then indeed as freely ſhone,
As if her Rays had been her *own*:
For Darkneſs is the proper Sphere,
For *borrow'd* Glories to appear.

And I know a good deal of his Meaning in them; *as that the Moon borrows her Light from the Sun*, &c. but I could be glad if you would explain a little upon that Matter, and upon her Motion round the Earth; after we have at Night examined her Face by the Teleſcope: Is this a good Time to look at her?

Yes, Madam, ſaid I, a very lucky one, for ſhe is now increaſing, and not quite full; we ſhall ſee her *Mountains* more diſtinctly, and the Light of the Sun move from one Hill to another.

The Evening, according to our Wiſhes, proved very clear and fair, and the Lady was mightily pleaſed with the *Face* and Appearance of the Moon through the Glaſs; and having alſo the Day before been reading a litle in Mr. *Huygens*'s *Coſmotheoros*, or his Celeſtial Worlds diſcovered, or Conjectures about Worlds in the Planets; and in Mr. *Whiſton*'s late Book, called, *Aſtronomical Principles of Religion*; ſhe was prepared to aſk me ſome very proper Queſtions, and began thus:

Pray, Sir, ſaid ſhe, is not our Earth a *Moon* to the Lunar People, as well as *ſhe* is to ours?

Yes, Madam, ſaid I, and a moſt uſeful and glorious one too; and we may, in ſome meaſure, perceive *that* ourſelves, by the Light which our Earth reflects upon the Moon before ſhe is juſt *new*, and for ſome

Time after; for doubtleſs *that* is the *only* Light that then renders her viſible to us: And when you conſider that the Light of our Earth, conſidered as a *Moon*, will be thirteen Times greater than that of the *Lunar Light* to us, it will not appear ſtrange, that it's Reflection on the Moon ſhould render her *then* dark Body viſible to us. However, this Terreſtrial Light, when the Earth appears at Full to the People in the Moon, is not above a 3600*th* Part of the Sun's Light there, as the Light of our Full Moon to that of the Sun, ſhining upon us, is about as 1 to 48,000.

I thank you for this, Sir, ſaid ſhe, and am heartily glad *we* can be ſo uſeful to the *Lunar World*. But, pray, go on: I perceive, ſaid ſhe, you agree that the Moon as well as the reſt of the Planets, turns round her own Axis, which, methinks, in her is very ſtrange; for we ſeem to diſcern always the ſame Face of her, without any Variation: Pray, in what Time is that Motion performed?

Juſt in the Time, Madam, ſaid I, that ſhe is revolving round the Earth; which I will explain to you preſently: But, firſt, it will be proper to inform you, that the Figure of the Moon not being exactly globular or ſpherical, but a little oval, or like that of an Egg, her longeſt Diameter (which exceeds her ſhorteſt by about 200 Foot) would, if you ſuppoſe it extended ſo far, paſs through the Center of our Earth: And hence it is that we always ſee the ſame Face of the Moon obverted towards us; and that *this* is not hindered by her Motion round her Axis, this familiar Inſtance will ſhew you. Pleaſe to ſit ſtill, without turning yourſelf, while I walk round you; you will then ſee plainly, that if I keep my Face always towards one and the ſame Point of the Compaſs, while I am moving round you, when I come a Quarter of my Circle, my Right-ſide, and not my Face, will be towards you; when I have gone half way round you, my Back; and when I am gotten three Quarters, my Left-ſide will be turned towards you; but if, as I move in my *proper Orbit* round you, I always keep turning towards you, as inded I cannot help doing, you will then always obſerve me beholding you with the ſame Face of Reſpect and Eſteem.

You Men, ſaid ſhe, are not like thoſe conſtant Celeſtial Lovers; for you ſeldom continue your Reſpect for above a Revolution or two: However, you may now ſtop in your *Circular March*, continued ſhe, for I ſee the thing plain, and that the Reaſon why we ſee always the ſame Face of the Moon, is becauſe ſhe moves round her *Axis* in the ſame Time that ſhe performs her Circle round the Earth: But, pray, let me know ſomething more of the manner of her Motions.

Madam, ſaid I, the Moon revolves continually from Weſt to Eaſt, and that pretty nearly in the ſame Circle which we call the Ecliptic; but not exactly ſo, ſometimes running 5 or 6 Degrees above it to the North, and ſometimes below it to the Southward: She doth not alſo keep always the ſame Diſtance from the Earth; as appears by her Diameter, which when we come to meaſure, we find ſometimes conſiderably larger than at others; ſhe moves ſwifter in the *Syzygies*, as they call them, that is, in their *Conjunction* with, and *Oppoſitions* to, the Sun, than ſhe doth at her

Quadratures, or when ſhe ſhews juſt half of her Face.

Well, ſaid ſhe, I perceive now that her Motion is ſo irregular, that ſome Compariſons, which have been made with her, are not quite groundleſs: But this Part I fancy I ſhall get over by my Books, and I think I know alſo, that the Reaſon why ſhe appears *full*, is, becauſe ſhe is then *oppoſite* to the Sun, who ſhines *full* upon her; and we loſe the Sight of her in what we call the *New Moon*, becauſe ſhe is then between us and the Sun, or in Conjunction with him; and it is eaſy to ſee alſo that all her other *Changes* and *Appearances*, or *Phaſes*, as I remember you call them, are accountable from her being in ſome *intermediate Poſition* between *new* and *full.* But, pray, Sir, why have not we an Eclipſe of the Sun at every *new* Moon, and one of the Moon at every *full?*

That is owing, Madam, ſaid I, to the Moon's Latitude, by which ſhe runs ſometimes 5 or 6 Degrees from the *Ecliptic*, (in which the Earth always moves) both Northward and Southward. But if her Orbit, and that of the Ecliptic, were all in one Plane, there would be total and central Eclipſes at every *new* and *full* Moon.

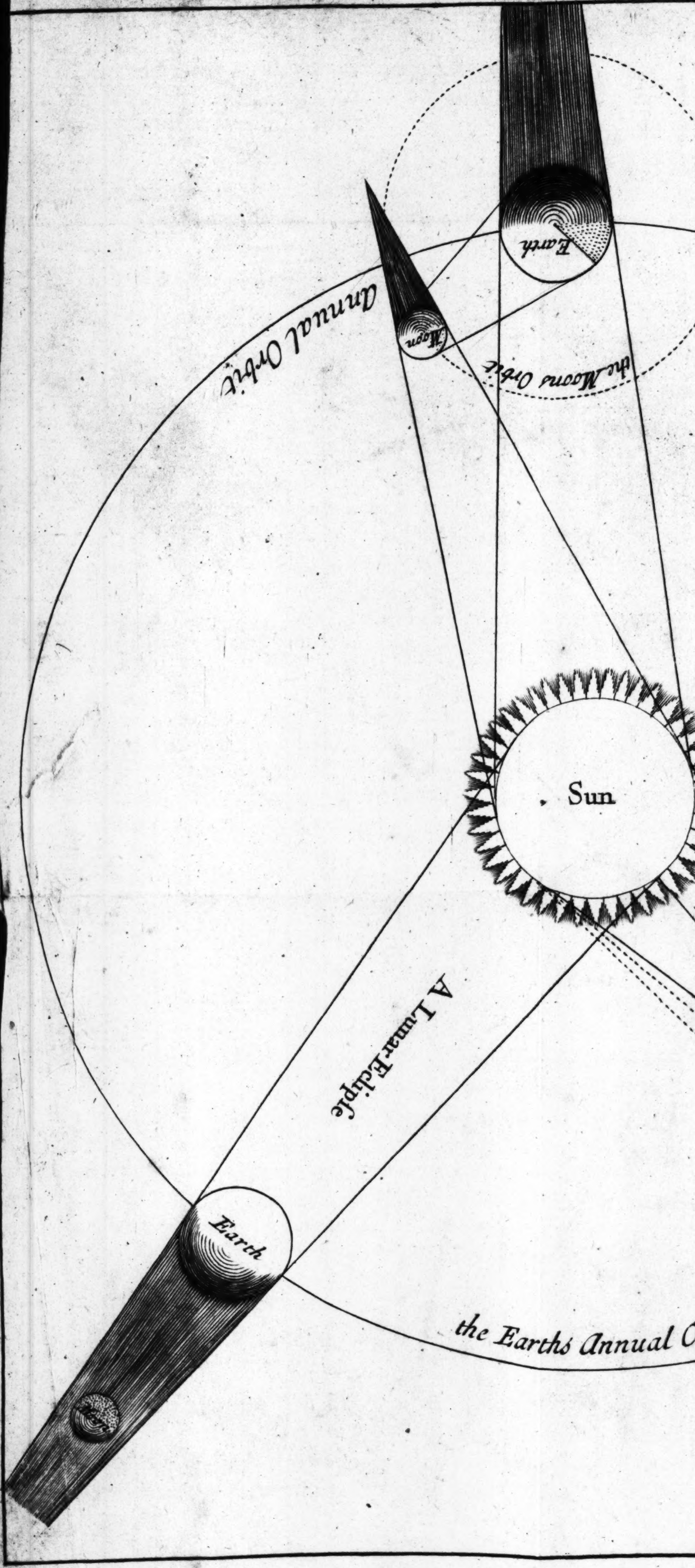
I conceive what you ſay, ſaid ſhe; ſo that there can be no *Eclipſe* of either Sun or Moon, unleſs the Moon be in the Ecliptic as well as the Earth, becauſe the Sun's Light will go *by* or *beſides* the Earth or Moon.

You have it exactly right, ſaid I, Madam, in general; all that I need tell you further is, that if the Moon have but a *very little* Latitude, an Eclipſe may happen; or if ſhe be at the Time of the *Conjunction* with, or *Oppoſition* to, the Earth, in or near the *Nodes*, as they call it, that is, the Points where the Moon's *preſent* monthly Circle croſſes the Ecliptic. And this falling out commonly twice in every *Synodical* Month, or *Lunation*, as we call it, there would be an Eclipſe of the Sun every *new* Moon, and an Eclipſe of the Moon every *full*, if the Earth could ſtay about the *Nodes*, and did not proceed on in her Orbit all this while, or change her Place in the Ecliptic forward on. However, within the Compaſs of the Year, there happen uſually four notable and almoſt total Eclipſes, ſomewere or other, two of the Sun, and two of the Moon. But your Ladyſhip will pleaſe to conſider, that there is in the Nature of the thing a great deal of Difference between theſe two kind of Eclipſes: For in the *Lunar Eclipſe* there is a *real Loſs* of the Moon's Light; for the Moon being immerſed in the Earth's Shadow, receives none of the Rays of the Sun, and therefore can reflect none of them to the Earth: And it is alſo over the whole Earth the ſame, from whenceſoever it is ſeen, not being changed by the diverſe Poſition of the Spectator on any Part of the Earth's Surface, whether he be in the Equator, or at the Poles.

But in an *Eclipſe of the Sun*, there being no real Loſs of the Sun's Light, but only an Interception of part of it, from coming to our Eyes, by the Interpoſition of the Moon's Body; this Eclipſe muſt appear different according to the different Places on the Earth, from which a Spectator may obſerve it: For though to that Part of the Earth to which the Center of the Moon is then interpoſed between the Obſerver's Eye, and the Sun's Center, it will be *total*, yet it will be but a *partial* one to all other Places, and none at all to the remote ones, as you will eaſily ſee by *Plate* III.

I thank you for explaining the *Nodes* to me, ſaid ſhe, and theſe Phænomena of Eclipſes; and by it you have now ſaved yourſelf the Trouble of anſwering many Queſtions: And I perceive, for the future, I ſhall get to underſtand theſe kind of Things and their Terms of Art, pretty well: My *Lexicon Technicum* is a ready Help to me in time of Need, and I believe the Doctor compoſed it out of a peculiar Regard to our Sex; I am ſure we are very much obliged to him for it. But have we any thing further to ſay about this *Vagrant*, the Moon, of whom *Dryden* ſpeaks a little coarſely, methinks, in his Tranſlation of *Ovid:*

Nor equal Light the unequal Moon adorns,
Or in her wexing, or her waneing Horns;
For every Day ſhe wanes, her Face is leſs,
But gathering into Globe, ſhe fattens at Increaſe.


Annual Orbit
Earth
Moon
the Moons Orbit
Sun
A Lunar Eclipse
Earth
Moon
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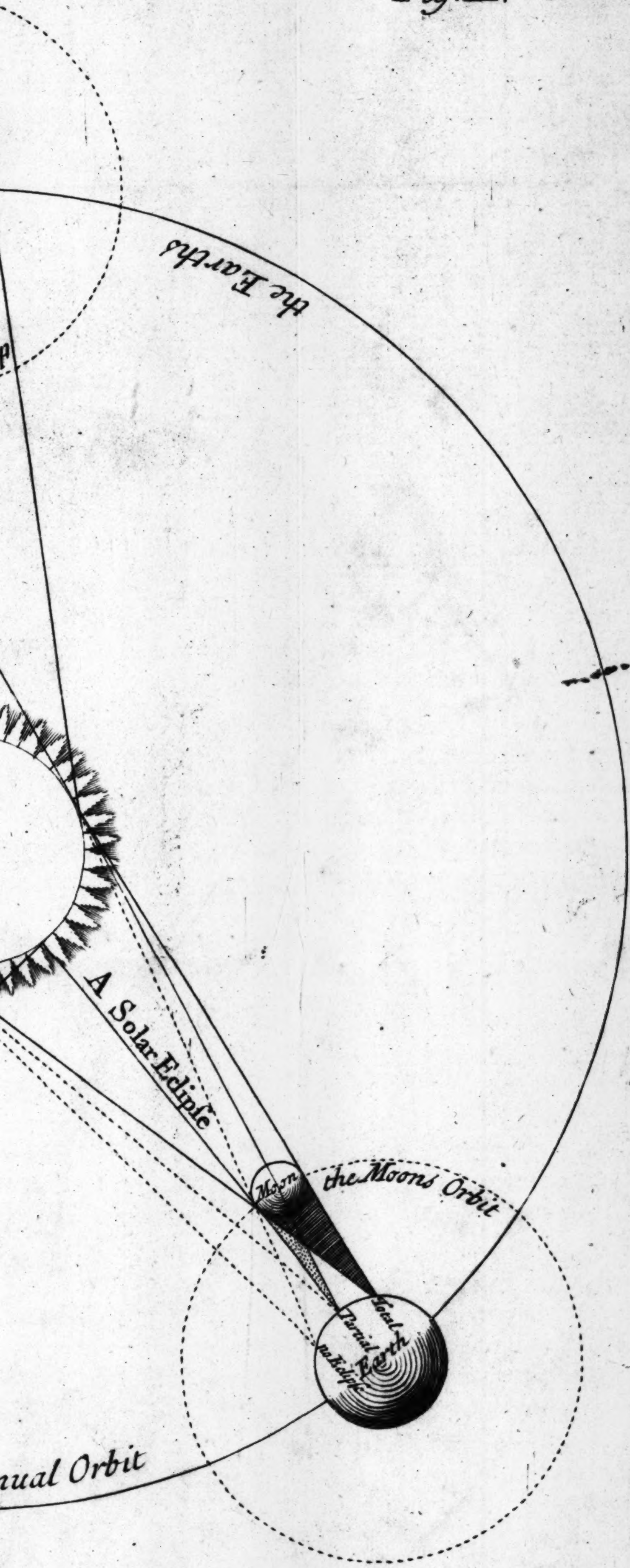
P. 104

Fig. III.


the Earths
nual Orbit
A Solar Eclipse
Moon
the Moons Orbit
Total
Partial
no Eclipse
Earth

Madam, ſaid I, happy is your Taſte in every thing! A piercing Judgment, great Memory, ſedate Conſideration, and fine Luxuriances of Wit, ſeldom unite in one Perſon; but you are adorned with all.

Pray, Sir, ſaid ſhe, ceaſe your high Strains, or elſe I ſhall begin to think, as *Hudibras* expreſſes it, That

The Queen of Night whoſe vaſt Command
Rules all the Sea, and half the Land;
And over moiſt and crazy Brains,
In high Spring-Tides at Midnight reigns,

had laſt Night ſome Effect on my *Teacher*'s Head.

Madam, ſaid I, between you both, I own I am now and then a little fluttered. —— But your laſt Verſes mentioning the *Tides*, put me in mind of another great Influence and Uſe the Moon hath over this Earth, beſides the great Light ſhe gives us; and that is, that ſhe is the principal Cauſe of our *Tides*, which are ſo beneficial to us, in keeping our Ocean ſweet by their Motion; and in helping the Navigation of our Ships in Rivers, and Places of the Sea, near the Shores. But I will refer you to the *Lexicon Technicum*, under the Word *Tides*, for an Account of it, where you may receive full Satisfaction, with regard to this Affair; *formerly* ſo very unaccountable, but *now* very clear and intelligible.

I cannot leave, ſaid ſhe, this inconſtant Planet, whom your ill-natured Wits have ſo often made the Reſemblance of our Sex, without aſking you a Queſtion or two more; What is that you call the *Hunter's Moon?* I have heard the jolly Fox-Chacers talk much about it.

Madam, ſaid I, what they mean by it, I do not underſtand; but I ſuppoſe it muſt be ſome very *long Moon*, which ſhines a great while about the Hunting-Seaſon, and ſo hath become eminent that way, though this cannot always ſo happen: But if you will pleaſe to go to the Globe yonder, you will eaſily ſee, that when the Moon is in *Cancer*, her *Sweeps*, or the Ark which ſhe makes above our Horizon, will be vaſtly larger than when ſhe is on the other oppoſite Side of the Equator in *Capricorn*; and if it then happen to be *full Moon*, or pretty near it, (as will be the Caſe next *October*) the enlightened Ark of her Motion above the Horizon will be very large and conſpicuous, in compariſon of what ſhe will run when her *full* ſhall happen to be in *Capricorn*. Alſo ſhe will riſe for ſeveral Nights nigh the ſame Point of the Compaſs, becauſe 13 Degrees on either Side of the Tropic has very nigh the ſame Declination with the Tropic: But the Moon's Latitude will not much help to account for this Phænomenon; for *that* is greater at her *Quadratures*, *i. e.* when ſhe appears an Half-Moon, than at the *Syzygies*, as we call them, *i. e.* at *New* or *Full Moon*; or when the Sun, Moon, and Earth are all nearly in one Right Line.

I think I apprehend this, ſaid the Lady; and now for the reſt of my Queſtions. What is the *Diameter* and Magnitude of this Planet? What is her Motion? What Proportion doth ſhe bear to our Earth? And do you think ſhe is inhabited as we are?

Her Diameter, Madam, ſaid I, we reckon to be almoſt 2,200 Miles; in Degrees, when taken with an Aſtronomical Inſtrument, it is about 32 Min. 12 Seconds, which is nearly the ſame with the Sun's apparent Diameter, for that is but 31 Min. 27 Seconds; her Magnitude, or rather her *Maſs*, or the Quantity of Matter in her, with regard to the Earth, is about $\frac{1}{40}$ Part; but then the Denſity of her to that of the Earth, is as 9 to 5; ſo that if ſhe hath any Inhabitants, as I take it to be highly probable all the Planets have, they cannot be of *ſuch Conſtitutions* as we are. And though ſome of out Aſtronomers have lately concluded from ſome Obſervations made in Eclipſes of the Sun, that ſhe hath an *Atmoſphere*, or Air about her like our Earth; yet it is probably of a very different Nature from ours, without any Clouds, Rain, Hail, or Snow; becauſe, whenever our Air is clear, we can always diſcern the Moon's Face, with, as well as without, a Teleſcope, to be bright, clear, and diſtinct: Which I think could not well be, if her Atmoſphere were like ours.

The exact Time of her periodical Revolution round the Earth, is in 27 Days, 7 Hours, and 43 Minutes, and this is called her *Periodical Month*; in which Courſe ſhe runs about 2,200 Miles in an Hour. But her *Synodical* one, as they call it, or the Time from *New Moon* to *New Moon*, is 29 Days, 12 Hours, and $\frac{3}{4}$ of an Hour.

Pray, ſaid the Lady, what occaſions this Difference of above 2 Days and 5 Hours, between theſe two kinds of *Lunar Months*?

The Reaſon, Madam, ſaid I, you will eaſily apprehend; and it is this: While the Moon is revolving round the Earth in her *Periodic* Month, the Earth itſelf is moved on in her Orbit round the Sun almoſt an entire Sign, or one twelfth Part of the *Ecliptic*: And therefore *that Point* in the Moon's Circle or Orbit, where the laſt Conjunction with the Sun was made, will now be gotten too far to the *Weſtward*: For the Sun being got forward 27 Degrees from the Place where the laſt Conjunction was, the Moon muſt move forward till ſhe overtake the Sun, which will take about the Space of two Days; ſo that although the Moon comes to the ſame Place of the Ecliptic again in 27 Degrees, 7 Hours, 43 Minutes, yet ſhe takes 29 Degrees, 12 Hours, and $\frac{3}{4}$ from the Time ſhe ſeparates from the Sun till the Time ſhe overtakes him again, which is the Synodical Moon; in which Time the Moon exhibits all her Phaſes.

I hope ſaid ſhe, I ſhall get to conceive this a little better by Degrees; but pray let me go on now, and aſk you a Queſtion or two more: I have been thinking, that the Inhabitants of the Moon muſt have one thing very odd and ſtrange; and that is, that to one Half only of their World *our Earth*, which I am appriſed muſt appear as a *Moon* to them, can be viſible: So that their other Hemiſphere will be for ever deprived of the Advantage of a Moon's Light.

O! Madam, ſaid I, if your Speculations lead you into ſuch Depths, we have you ſafe for an Aſtronomer; and I do not doubt but that will lead you alſo into the Study of ſuch other Parts of Mathematics, as, the more you know of them, the more you will find them neceſſary. And I could now tell you a great many ſurprizing Things about the Appearance of our Earth to the Inhabitants of the Moon; but I wil not deprive you of the Pleaſure of reading them yourſelf: you will find them fully enlarged upon at the End of Dr. *Gregory*'s *Aſtronomy*, which is lately tranſlated into *Engliſh*; which you will find among thoſe Books, that according to your Commands, my Bookſeller ſent you laſt Night from *London*.

Very well, Sir, ſaid ſhe; I ſhall be impatient till I get ſome further Knowledge of that Matter. But we will now take our Leave of Mrs. Moon; and, if you pleaſe, go *down*, as you call it, toward the Sun: and from thence aſcend again; taking the reſt of the Planets in their Order, according as this Diagram here repreſents them; which you have kindly drawn for me; and which you call a Scheme of the *Solar Syſtem*. Pray therefore, good Sir, tell me as much as you think I can underſtand, about *Mercury*, the neareſt Planet to the Sun.

Mercury, Madam, ſaid I, is a Planet whoſe Diameter we reckon to be about 2,700 Miles; and therefore he is about two Thirds of the Earth's Magnitude. His Diſtance from the Sun is about 32 Millions of Miles; and his mean Diſtance from us, about 22,000 of the Earth's Semidiameter, or 88,000,000 Miles, according to *Caſſini*'s Numbers. He revolves round the Sun in ſomething leſs than 88 Days, with the Velocity of 100,000 Miles in an Hour; which is almoſt as faſt again as the Earth travels: for we do not go above 56,000 Miles in that Time; and yet that is making pretty good Speed too; for that do not want much of 1000 Miles in a Minute, or fifteen Miles in a Second; or in that Space of Time in which you can diſtinctly pronounce *one*, *two*, *three*, *four*. And yet however amazingly ſwift this may ſeem, it is crawling like the *American Ignavus*, or Beaſt called the *Sluggard*, in compariſon of the Velocity of the Rays of Light, which certainly move above 180,000 Miles in that Time.

What! in a Second? ſaid ſhe: Let me ſee——why, that is almoſt 50,000 Miles while I can ſay the Word *Light*,- For Godſake ſtop a little, or you will make me perfectly giddy: My Head will turn quite round. What! have you and I then been travelling almoſt 2,000 Miles together this

Morning, and I knew nothing of the Matter.

It is even ſo, Madam, ſaid I; and you ſee we move eaſily: But if you pleaſe, I will go on. The Heat of the Sun there, is probably ſeven Times, (Mr. *Huygens* ſaith nine Times) as great as with us in the hotteſt Summer; which is, I believe, enough to make Water to boil. You will eaſily ſee, therefore, that his *Inhabitants* cannot be *ſuch* as we are; for our Bodies could by no means bear ſuch a Degree of Heat.

Our *Anceſtors* Bodies, ſaid ſhe, I believe could not: but by our drinking ſo much *ſcalding Tea* and *Coffee* as we now do, I ſhould think we are preparing ourſelves to go and live there: And I ſuppoſe our famous *Fire-Eater* came from thence. There can be no Fluids ſure in this Fiery Planet, much leſs denſe, than *that* which bears his Name; and no doubt all Things elſe are denſe there in the ſame Proportion, or elſe the Sun would rarify him, and ſend all his Furniture off in Fume, Smoke, and Vapour.

Well! ſaid the Lady, as much as I hate frozen Zones, and bitter cold Weather, I think this Mercurial World to be worſe in the other Extreme; ſo I will never wiſh for a Voyage thither.

No, Madam, ſaid I, you will find this Earth to be a much more eligible Place of Abode for People of *our Make*, than any other which we yet have diſcovered in the beſt Planet of them all. As for this we are talking of, *Mercury* is ſo near the Sun, that he is very rarely ſeen by any but Aſtronomers, who know how to look after him. But about St. *George*'s Day laſt he was at his greateſt Diſtance from the Sun, and then about Eight in the Evening might have been ſeen very plainly.

Well, ſaid ſhe, I ſhall not much trouble myſelf to enquire after him; but I remember I ſaw him very plain and diſtinct, during the Total Darkneſs, in the laſt Eclipſe of the Sun; and that ſhall ſatisfy my Curioſity, till ſome other Opportunity offers it ſelf. But pray, Sir, doth the Teleſcope ſhew us any Thing remarkable about him?

Only, Madam, that he hath *Phaſes*, as we call them, like thoſe of the Moon, and ſometimes appears full, and ſometimes horned, like her, which you will eaſily conceive muſt be the Caſe of any Globe of Earth illuminated by moving round the Sun, and changing it's Poſition with regard to him, and to our Eyes. It hath not been yet diſcovered by any Spots or Marks upon him, that he revolves round his *Axis*, nor conſequently what the *Poſition* of that *Axis* is, though it is probable he performs that Motion in a certain and determinate Time, as the reſt of the primary, and I believe all the ſecondary, Planets do. *Venus* and our *Earth* muſt needs appear very bright and large to the Inhabitants in this Planet, and the former will ſeem ſix or ſeven Times larger than ſhe doth to us, which will help to ſupply the Want of a Moon to him in the Night. But there is one more very remarkable Phænomenon of him, and that is, that as his Orbit is within ours, he muſt ſometimes get between us and the Sun, and then he appears like a little black Spot in the Face of that Luminary, and may very eaſily be obſerved and diſtinguiſhed by a Teleſcope.

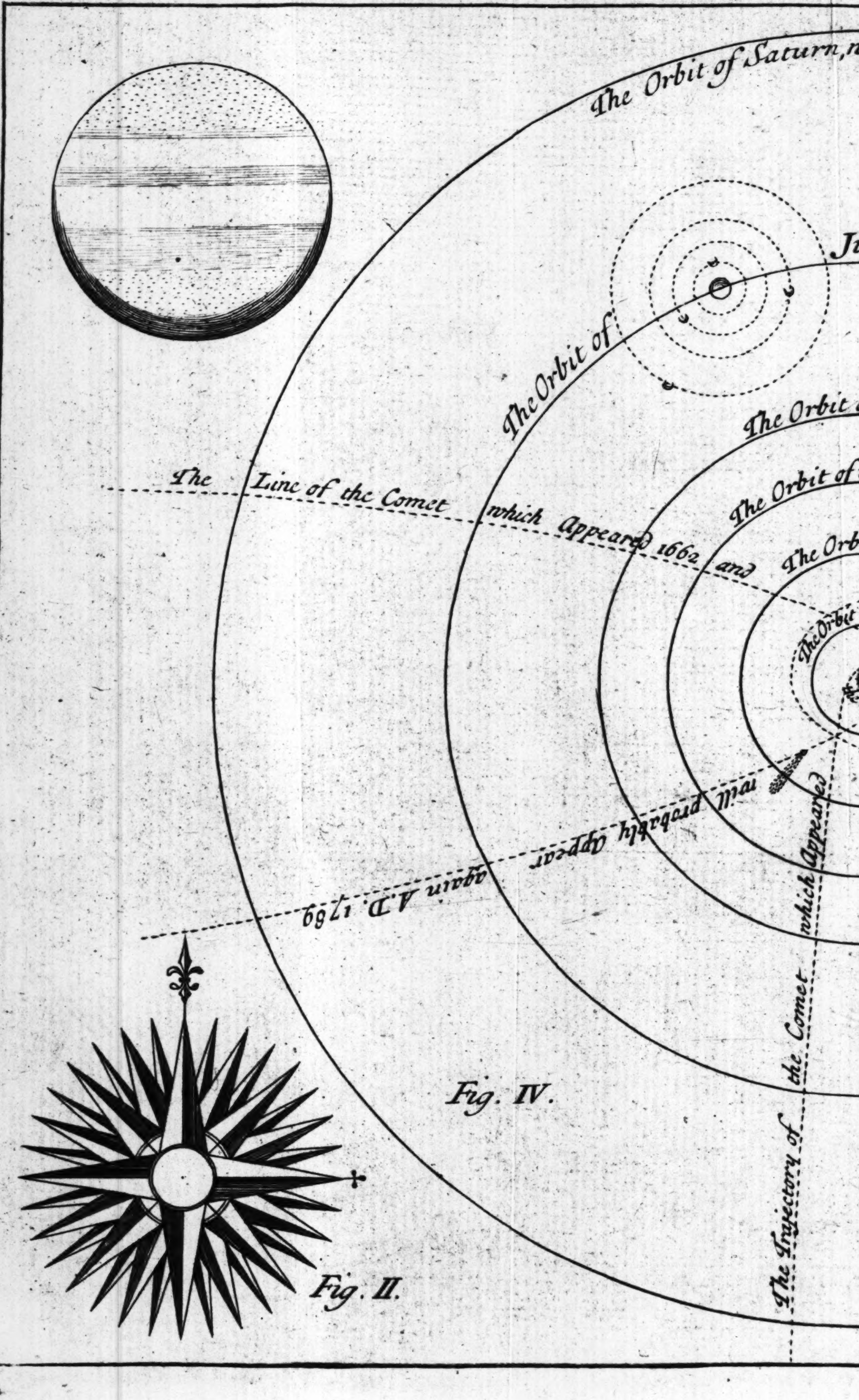
O, I am mightily pleaſed with this, ſaid the Lady, and ſhall I ever ſee him in that Poſition?

I hope you will many a Time, Madam, ſaid I, for he will be there in *April* 1720, and in *October* in 1723, which is but a little while hence and he will alſo be there again in *May* 1761.

Well, ſaid ſhe, I will then have a full look at him, if I live ſo long; and in the mean Time let this *Herald* of the Gods ramble on as he pleaſes; and let us talk next about *Venus*.

Beneath the ſliding Sun, who runs her Race,
Doth faireſt ſhine, and beſt become the Place:
For her the Winds their Eaſtern Blaſts forbear,
Her Month reveals the Spring, and opens all the Year.
With ſmiling Aſpect ſhe ſerenely moves;
Adorns with Flowers the Meads, with Leaves the Groves.
The joyous Birds her Welcome firſt expreſs,
Whoſe Native Songs her Genial Fire confeſs.

Dryden's Lucretius.


The Orbit of Saturn,
Ju
The Orbit of
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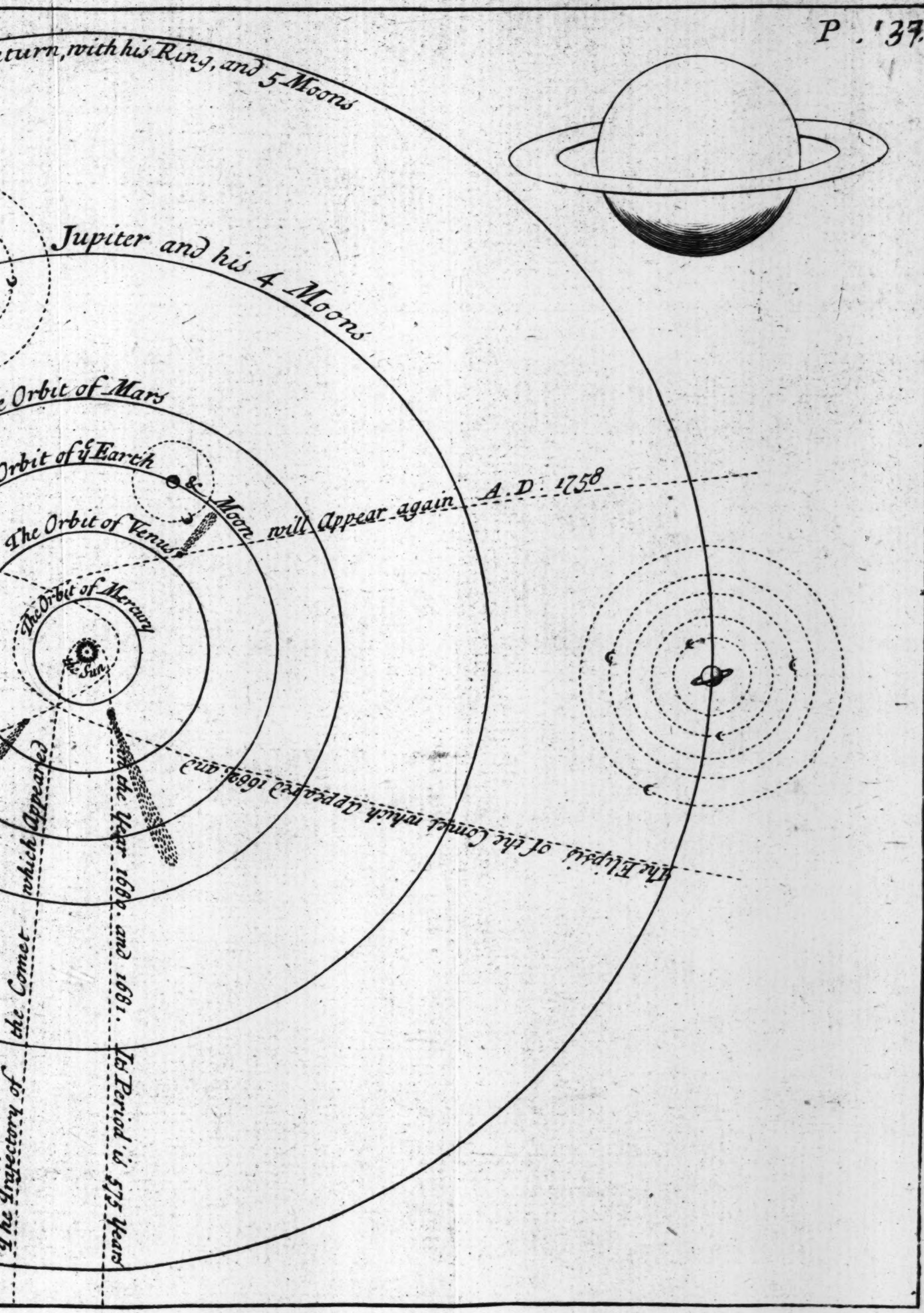
The Orbit of
The Orb
The Orbit
The Line of the Comet which Appeared 1662 and will probably Appear again A.D. 1789
The Trajectory of the Comet which Appeared

Fig. IV.

Fig. II.

P. 137.



turn, with his Ring, and 5 Moons
Jupiter and his 4 Moons
e Orbit of Mars
Orbit of ye Earth
& Moon
will Appear again A.D. 1758
The Orbit of Venus
The Orbit of Mercury
the Sun
The Ellipsis of the Comet which Appeared 1682 and
The Trajectory of the Comet which Appeared
the Year 1680 and 1681. Its Period is 575 Years

But whither am I running? Pray, Sir, ſtop me a little, and tell me ſome ſerious Aſtronomical Things about this celebrated Planet.

The Diſtance of *Venus*, ſaid I, Madam, from the Sun is about 60 Millions of Miles; and by ſome *Spots* which the Teleſcope hath diſcovered in her Face, ſhe appears to have a Revolution round her *Axis*: The Time of which ſeems to be about 23 Hours. But neither *Caſſini* at *Paris*, nor our Mr. *Hook* here, though they plainly ſaw the Spots to move, were able, poſitively and expreſſly to determine the Time of her Diurnal Rotation round her *Axis*; though the former takes it, as I ſaid before, to be in about 23 Hours; and therefore *that* will be the Length of her Natural Day. Her Motion in her Orbit round the Sun, is performed in a little above 224 Days, and her Motion in an Hour is about 70,000 Miles.

That is pretty fair, ſaid ſhe, too for a Lady; but I am glad ſhe doth not fly quite ſo faſt as the laſt *Whirlegig Mercury*, however: But pray, Sir, go on.

This Planet, Madam, ſaid I, Mr. *Huygens* takes to have a large Atmoſphere which reflects ſo ſtrong and glaring a Light, that her Body is rarely ſeen clear and diſtinct. She alſo hath *Phaſes* like the Moon, as was before obſerved of *Mercury*; ſhe hath no *Satellites*, Attendants, Moons, or Secondary Planets moving round her, becauſe, as you very juſtly obſerved a while ago, *Mercury* and ſhe being ſo near the Sun, have no occaſion to be enlightned by *Moons*, as our Earth, *Jupiter*, and *Saturn* have. Indeed *Caſſini*, in the Years 1672, and 1686, with a Teleſcope of 34 Feet, fancied he ſaw a *Satellite* moving round her, whoſe Diameter was about a quarter Part of that of *Venus*: And Dr. *Gregory* thinks it not improbable, that this might be really a Moon to this Planet, and takes the Reaſon of it's not being uſually ſeen, to be, the Unfitneſs of it's Surface to reflect the Rays of Light: But as no ſubſequent Obſervations have confirmed this, I look upon it no more than a Conjecture. Neither ſhe nor *Mercury* ever come ſo much as into *Quadrature* with the Sun, much leſs to an Oppoſition to him; and indeed, their utmoſt *Elongation* from him, as we call it, or greateſt Diſtance Eaſt or Weſt from the Sun, never amounts to above two Signs; *Mercury* not going above 28, and *Venus* never above 48 Degrees from the Sun. She is much about the Bigneſs of our Earth: And the Light and Heat of the Sun, is about four Times as great as it is with us.

I am heartily ſorry, ſaid the Lady, that it is ſo; for I would fain have had this beautiful Planet to have been inhabited by juſt ſuch fine Gentlemen and Ladies as we have here; but I find it will not do; the Women would be there all as ſwarthy as Gipſies, and fry and ſweat like *Negroes* in *Africa:* Out upon it! I am afraid I ſhall find never a Planet fit to be inhabited by ſuch People as you and I are.

Madam, ſaid I, take care; you are falling in with Aſtrologic Whimſies; one would think you had read *Athan*, *Kircher's Iter Extaticum*, which agrees with your Wiſhes as to *Venus*, *Mercury*, and *Jupiter*; but he makes *Mars* all Smoke and Fire, and *Saturn* nothing but dull Lead, Dirt, and Naſtineſs, as you will find when you come to look over Mr. *Huygen*'s Planetary

Worlds, which I have ordered the Bookſeller to ſend you.

You are always cautioning me againſt Aſtrology, ſaid ſhe, and I muſt thank you for it. But I have heard that their *beginning* with that Study, hath made ſome Men become good Mathematicians, and even Aſtronomers: Shall I name them to you, Sir? You have forgot what you have told me of ſome of your Friends. But enough, let us proceed, and before we have quite done with this warm Dame, will you pleaſe to tell me why ſhe is ſometimes our *Morning*, and ſometimes our *Evening Star?*

That depends, Madam, ſaid I, on her Poſition, with regard to the Sun and us; when ſhe is in that Part of her *Orbit* which is below the Sun, or between him and us; then ſhe is the *Morning* [*Star*; but when ſhe gets into the oppoſite Part of her *Orbit* above the Sun, then ſhe becomes our *Evening Star*.

And under both theſe Denominations, ſaid ſhe, I think the Poets make her change her Sex, and turn *He-Thing*, as if ſhe could not be as uſeful when of *our Gender*, as of *yours*; for thus, forſooth, Mr. *Dryden* compliments the *Changeling:*

So from the Seas exerts his radiant Head,
That Star, by whom the Lights of Heaven are led,
Shakes from his roſy Locks the pearly Dews,
Diſpels the Darkneſs, and the Day renews.

And ſo that blind Creature *Milton* cries,

Bright *Heſperus* that leads the ſtarry Train, *&c.*

Marry come up indeed! Can nothing but Men ſerve you? Sure we have had Women every Way as well qualified to be Morning or Evening Stars as any bearded Tyrant of you all.

Madam, ſaid I, this is only owing to Cuſtom, which hath made it the Mens' Province to write Books and make Verſes, and ſo they compliment themſelves: But however, you may be pretty eaſy, when you reflect, that we uſually call the *moſt uſeful* things *She's:* Our *Saxon* Anceſtors and our plain honeſt Country Folk, now call the *Sun* himſelf, that Father and Governor of all the Planets, *She*; and ſo we agree to call Guns and Fowling-Pieces; nay, our Sailors are ſo well bred, and ſuch Lovers of your Sex, that they call a Ship *She*, though ſhe be a *Man of War*.

Well! ſaid ſhe, this is ſome kind of Atonement and Satisfaction; and therefore, at your Deſire, I will for this Time forgive the Goſſips of *Phoſphorus* and *Heſper*; but if they ſhould attempt to make *a Man of the Moon*, I will never paſs it by, for I can hardly be reconciled to thoſe that place a *Man* in that Planet. But have you any thing further to tell me about *Venus?*

Only, Madam, that *She* alſo ſometimes, like her Neighbour *Mercury*, hath appeared like a Spot in the Sun; as you will eaſily conceive ſhe may, when you conſider that the Orbit of the Earth includes her's within it; and that therefore ſhe muſt be ſometimes, though very ſeldom, between our Eye and the Sun, and then ſhe will appear like a Spot in the Sun's Diſk. The next Time that *Venus* will be ſeen in the Sun, will be *May* 26, 1761, a little before ſix in the Morning; I wiſh your Ladyſhip Health and Happineſs till the Time of that Obſervation,

vation, and that you may be then well enough to *get up* to ſee it.

O! Sir, ſaid ſhe, I can riſe betimes in a Morning, for a leſſer Occaſion than this: and I deſign to ſee that ſurprizing Appearance if it pleaſe God I live ſo long: But methinks it is little ungratefully done of the Moon, and theſe lower Planets, ſaid ſhe, thus to eclipſe him, or deprive him of any of his Light, when they receive all theirs from him; for I am almoſt afraid our Earth doth ſo too: For ſince ſhe is a Moon to the Moon, it muſt often be interpoſed between the Sun and Moon, and therefore for a Time deprive the latter of the Light of the former.

Upon my word, Madam, ſaid I, you begin to run great Lengths, and go deep into the very Heart of Aſtronomy: And if you will pleaſe to read Dr. *Gregory*'s *Comparitive Aſtronomy*, in the Place I before recommended to you, you will be glad to ſee how rightly you have reaſoned. Shall we proceed next, Madam, to talk about what they call the *Superior Planets*; and in particular about *Mars*, who next occurs in Order?

Yes, ſaid ſhe, we muſt take him in his way; but I hope you *Aſtronomers* have not ſuch terrible ſhocking Things to ſay of him as the *Poets* have. Mr. *Dryden*, I remember, gives ſuch a Deſcription of *Him* and his *Temple*, as when I read it, chilled me with Horror; and what is worſe ſtill, after he had enumerated all manner of Slaughters, Famines, Plagues, *&c.* he adds this:

Theſe and a thouſand more the Fane adorn,
Their Fates were written e'er the Men were born;
All copied from the Heavens, and ruling Force
Of this *Red Star*, in his revolving Courſe:
The Form of *Mars*, high on a Chariot ſtood,
All ſheath'd in Arms, and gruffly look'd the God.

No, Madam, ſaid I, we give him no ſuch Power of doing Miſchief in our *Hypotheſes*; but make him as calm and as gentle as any of the Planets.

Very well, ſaid ſhe, then begin, and ſay what you pleaſe of him.

They account the Diameter of *Mars*, Madam, ſaid I, to be about 4,400 Miles, and therefore he muſt be much leſs than our Earth: And his Diſtance from the Sun is about 123,000,000 Miles; he revolves about the Sun in 687 Days nearly, and runs at the rate of 45,000 Miles in an Hour.

Well! ſaid ſhe, this is pretty good marching too, for a Man in Armour. Sir, pray go on.

Madam, ſaid I, by ſome Spots which have appeared in him, the Time of his Diurnal Revolution, is by Mr. *Huygens* ſettled exactly at 24 Hours 40 Minutes; and the Motion of thoſe Spots hath alſo diſcovered that this Axis hath very little or no Inclination to the Plane of his Orbit; and therefore the *Martial* Inhabitants will have no ſenſible Difference between Summer and Winter. *Huygens* thinks that the Colour of the Earth in him is blacker than that of *Jupiter*, or the Moon. His Light and Heat is twice, and ſometimes thrice, as weak as what we receive from the Sun. When he is in his *Quadratures*, as they call it, that is, in the middle between his Conjunction with, or Oppoſition to, the Sun, he appears a little gibboſe, and to a good

Glaſs almoſt *biſſected*; but when at Full, perfectly round and diſtinct. The Teleſcope hath not yet been able to diſtinguiſh any *Moon*, or *Satellites* moving round him; but that will not be a demonſtrative Reaſon that there are none at all: For as they are at a great Diſtance from us, ſo they may be but ſmall, and reflect but a weak and ſmall Light, and therefore may not be viſible. The Proportion of Heat and Light in this Planet, in compariſon of ours, is not much above half.

O! ſaid ſhe, for all he looks *ſo red*, then I perceive the Planet is not ſo fiery as the Poets feign the *God of War* to have been. Pray, Sir, let us go on to *Jupiter*.

Vid. Fig. 4.

This, Madam, ſaid I, is the largeſt of all the Planets, and you ſee by the general Scheme, that he is much more remote from the Sun, than any of the Inferior Planets we have already been diſcourſing of, and therefore Heaven hath granted him a Supply of Light, by four Moons or Satellites, which revolve round him as our Moon doth round us; and theſe

Moons, like the Satellites of *Saturn*, are ſo much leſs than their primary Planets, that they are not viſible without long Glaſſes, and therefore were perfectly unknown until the laſt Age.

Theſe ſecondary Planets ſuffer four kinds of Eclipſes. (1.) When they are within the Shadows of their Principal. (2.) When the primary Planet is between them and us. (3.) When they are between their primary one and us; for then it is difficult to diſtinguiſh of two Luminous Points one from the other. (4.) When they interpoſe between one another and our Eye, ſo as to hide one another from our Sight; which indeed happens but very rarely. And all theſe Attendants or Satellites, as well as *Saturn*'s, like the Moon, the Earth's moſt obſequious humble Servant, do always turn their Faces towards their Lords the primary Planets, about whom they revolve, and on whom they wait.

This, ſaid ſhe, exhibits a good Image of Reſpect and Regard in Servants and Attendants; I wiſh our Earthly ones would imitate the Celeſtial.

Madam,

Madam, ſaid I, the Times of the Periodical Revolutions of *Jupiter*'s Moons round about him, are as follow:

The Innermoſt moves round him in 1 Day and 18 Hours, the ſecond in 3 Days and 13 Hours, the third in 7 Days and almoſt 4 Hours, and the outermoſt in 16 Days and 16 ½ Hours. In the *Lexicon Technicum*, you will find a good deal more about this Planet, and how the *Eclipſes* of his *Satellites* are calculated; and thence ariſes an eaſy way to find the Longitude on Shore: But I doubt it is not practicable at Sea. If this Evening happens to be clear, (as it promiſes well) I will ſhew you the Planet with his Attendants about him.

I ſhall long to ſee that Sight, ſaid ſhe; but pray go on, and tell me more about this noble Planet.

His Diameter, Madam, ſaid I, is above 80,000 Miles; and the Quantity of Matter in him is about 220 Times greater than that of our Earth; and his Diſtance from the Sun about 424 Millions of Miles: He revolves round his own Axis in 9 Hours and

56 Minutes, and about the Sun in 11 Years and 10 Months: And ſo large is his Orbit, that he moves after the rate of about 24,000 Miles in an Hour.

This Planet, ſaid ſhe, makes a great Figure by the Largeneſs of his Bulk, and the Grandeur of his Attendants; but pray what kind of Temperament hath the Air of *Jupiter?* I doubt it muſt be much colder than ours, and then I ſhall never deſire to be a *Jovian.*

Madam, ſaid I, the Heat and Light of the Sun cannot be above a 27th Part of what we enjoy here, and therefore it muſt be very dark, diſmal, and cold, living there; and the Weight of all Bodies will be double to what they are on our Earth.

Nay, ſaid ſhe, if the People be twice as heavy, and almoſt 30 times as cold as we are, even let them live by themſelves for me; I will never hanker after going thither, but content myſelf with ſome *jovial* Friends here in our dirty Planet, as Dr. *Burnet* called it; but I ſhall never have much value for his Judgment any more, that repreſented *Jupiter* as the Pattern of the fine

Antediluvian World. But pray, Sir, what Diſtance may theſe 4 Moons of *Jupiter* be from his Body?

The neareſt, Madam, ſaid I, is about 130,000 Miles from that Planet; the ſecond about 364,000; the third 580,000; and the fourth or outermoſt is about a Million of Miles diſtant from him.

What a fine Appearance muſt theſe four Moons make, ſaid ſhe, and what frequent Eclipſes of the Sun, and of one another, do they produce! And if *Jupiter* hath any Ocean, and it be not always frozen up like the *Baltic* in hard Winter, what whiſking Tides muſt they produce *there*, ſince our own Moon hath ſo great an Effect *here* in that reſpect?

Madam, ſaid I, I ſee you do not only advance in *Aſtronomical*, but even in *Phyſical* or *Natural* Knowledge: That Speculation about the *Tides* of *Jupiter* is curious and new, and will be worth a further Purſuit. But if you pleaſe, we will now go on with our Planet's *Phænomena*. You ſee by the *Figure of Jupiter*, that beſides a famous Spot by which his Diurnal Motion was determined, there are Appearances in him like Swathes or *Belts*, as they call them: Theſe they take to be moveable, and to be formed by the Clouds of this Planet, which ſeem, like our Trade-Winds, to lie in Tracts parallel to the *Equator* of *Jupiter*.

And if theſe are really Clouds, ſaid ſhe, would not it be a proof of *Jupiter*'s having a vaporous Atmoſphere about him, like that of our Earth.

It will doubtleſs ſhew, ſaid I, Madam, that he hath ſomething round him like our Air: but it's Texture, Gravity, and Elaſticity may notwithſtanding be vaſtly different from that of Ours; but if by it you mean to inſinuate *that he is inhabited*, I entirely agree with you; for I take it, that ſuch an *Apparatus* as the making four Moons to revolve about, and to enlighten him; (as five ſuch there are alſo moving round *Saturn*, beſides his Ring) I take this, I ſay, to be a demonſtrative Proof of both theſe Planets having *ſome kind of Inhabitants*, who have Eyes to ſtand in need of *Light*, as well as *other Senſes* proper for their Natures: For we never find Nature doing any Thing in vain, but ordering all Things with the moſt conſummate Wiſdom; and we muſt never believe ſhe would form Moons, where there are no People to be lighted by them.

Do you think, ſaid ſhe, that our Earth can be ſeen by the *Jovial* Inhabitants?

No, Madam, ſaid I, by no means.

Lord! what vain Creatures we are, ſaid ſhe, in this Earthly Planet? What a Buſtle do we make to extend our Power and Empire over it? But I am mighty glad the impertinent and deſtructive Ambition of an *Alexander* or a *Louis le Grand*, cannot be heard of in *Jupiter*; and I hope the Heroes *there* are always exerting themſelves for the good of their People. How vain is it alſo in ſome of our Divines, to ſuppoſe *Jupiter*, as well as the reſt of the Heavenly Bodies, to be made *only* for the Uſe of Mankind? When yet, neither in him nor in *Saturn*, can the Place of our Habitation be ſeen. But pray, Sir, go on.

This, Madam, ſaid I, I think is all that is very remarkable about this famous Planet, except one thing more, which is indeed very conſiderable and ſurprizing: And that is this; that by the Eclipſes of *Jupiter*'s Satellites, made by the Interpoſition of his Body between them and our Eye, it hath been diſcovered that Light is in it's Motion *Progreſſive*, and not *Inſtantaneous*, but that it takes up a determinate Time to come from *Jupiter* to our Eyes: For they have obſerved that theſe Eclipſes happen *ſooner* than they ought to do, by Calculation, when *Jupiter* is neareſt to the Earth, and when *Jupiter* is fartheſt removed from our Earth, then thoſe Eclipſes do not happen ſo ſoon as they ſhould do by Calculation. The Difference between *Jupiter*'s neareſt and fartheſt Diſtance from our Earth is the Diameter of the annual Orbit, and the Difference of the Eclipſes of *Jupiter*'s Satellites appearing ſooner or later than the Time by Calculation; and thoſe Differences being ſtill the ſame, according to the Diſtance of *Jupiter* from our Earth, it is therefore exactly found by Obſervation, the Time that Light takes to move the length of the Diameter of the annual Orbit of our Earth. And by thoſe Obſervations it is found that Light moves from the Sun to us in 7½ Minutes of Time: And on this Calculation it was, that what I told you before about the prodigious Velocity of the Rays of Light, was founded.

I ſhall look a little further, ſaid ſhe, into this Affair ſome other Time; but, pray, let us now go on to talk about *Saturn.*

That outermoſt Planet in our Syſtem, Madam, ſaid I, is at a very great Diſtance from the Sun, about 777 Millions of Miles; and the Time of his Revolution round him, is about 30 Years, or more exactly ſpeaking, in 10,759 Days, 6 Hours and 36 Minutes: And yet ſo very large is his Orbit, that he moves at the rate of about 18,000 Miles an Hour; his Diameter is about 61,000 Miles; and with regard to the Quantity of Matter in him, it is about 94 Times as great as that of our Earth; but his Denſity is not much above a 7th Part of that of the Matter of our Planet. And as to Light and Heat, it is probable that he hath not above a 90th

Part of what we enjoy by the Sun. Indeed in order to ſupply this great Defect of the Sun's Light, occaſioned by ſo great a Diſtance, our All-wiſe Creator hath furniſhed him with *Five Moons* or Attendants; the largeſt of all which, and which is the only one that is commonly ſeen, is the 4th in order from his Body; and he bears the Name of the *Huygenian Satellite*, becauſe firſt diſcovered by Mr. *Huygens*. Theſe Satellites of *Saturn* revolve round him in the *Plane* of his Ring (of which Ring I ſhall ſpeak preſently) and ſo their Circles make the ſame Angle with his Orbit, that the Plane of his Ring doth, which is about 31 Degrees. But the Orbit of *Saturn* himſelf is nearly coincident with the Plane of our Earth's Ecliptic, as are indeed the Orbits of all the primary Planets. It doth not yet, I think, appear, that *Saturn* hath any Diurnal Revolution round his own *Axis*; the Time of his Periodic Motion round the Sun, I gave you before; and thoſe of his Satellites are as follow: The Innermoſt of theſe Moons revolves round *Saturn* in one Day, 21 Hours and 20 Minutes, and is diſtant from him about 146,000 Miles. The ſecond is diſtant from him about

187,000 Miles, and performs his Revolution in 2 Days, 17 Hours and 40 Minutes. The third's Revolution takes up 4 Days, 13 Hours and 45 Minutes, and he is diſtant from the Center of *Saturn* about 263,000 Miles. The *Huygenian* Satellite is about 600,000 Miles from him, and moves round him in 15 Days, 22 Hours and 40 Minutes. The laſt is 1,800,000 Miles diſtant from *Saturn*, and takes up 79 Days, 22 Hours, in revolving round him.

It is highly probable that there may be more Satellites than theſe five moving round this remote Planet; but their Diſtance is ſo great, and their Light may be ſo obſcure, as that they have hitherto eſcaped our Eyes, and perhaps may continue to do ſo for ever; for I do not think that our Teleſcopes will be much farther improved.

But the moſt ſurprizing and unparalleled *Phænomenon* of all, in this Planet, is that which we call *his Ring* *; which appears nearly as the Figure repreſents it, in an ordinary Teleſcope: It is a vaſt Body of Earth, as is moſt probable, of perhaps 7 or 800 Miles in thickneſs, which at the Diſtance of about 21,000 Miles from *Saturn*'s Body, and with juſt as great a breadth, is placed in a circular Arch, round about the Planet, in Figure much like the great Wooden Crane-Wheels, in which Men or Horſes walk, to raiſe Goods, or to draw Water. It is placed exactly over the Equator of *Saturn*, and is not any way contiguous to his Body, nor ſupported by any thing. The *Surface* of this Ring is not rough and full of Hills and Protuberances, as *that* of the Moon in moſt Places is; but even and plain, as it is in thoſe Regions of the Moon, which ſome, becauſe of their great Evenneſs, have judged to be *Seas*.

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* *Vid.* Figure of *Saturn*.

The Thickneſs of the Ring comes not into Aſtronomical Obſervation, appearing but as a Line. And though the two broad Surfaces of the Ring reflect a good deal of ſtrong Light, yet the marginal Surface of it, or it's Edge or middle Part between the two eminent Surfaces, reflects hardly any at all. The Plane of the Ring is inclined to that of the Ecliptic, with an Angle of about 31 Degrees; and this Inclination in the Courſe of one entire Revolution of *Saturn* round the *Sun*, hath ſome Variation; being twice *greateſt*, and twice the leaſt of all. And this occaſions the Planet ſometimes to appear without any Ring at all, as when the *Sun* happens to be in the Plane of the Ring; and at other Times, with *Anſæ*, as they call them, or *Handles* only; when but little of the Surface of the Ring can be ſeen: And at all other Times the Ring will appear in an oval Form, which ſometimes will be more, ſometimes leſs *oblong*.

I ſuppoſe, ſaid the Lady, it is at that critical Time when the *Anſæ* only appear, that *Saturn* puts on the Figure which *Hudibras* makes *Sydrophel* give him, that is, that it is like a *Tobacco-Stopper*.

That is but a mean Ridicule, ſaid I, Madam; but I perceive it hath ſome Uſe; for it impreſſes itſelf, and the Thing, ſtonger on the Memory, than perhaps a more juſt and ſerious Deſcription would have done. But your Ladyſhip will ſoon be above theſe little Helps: And you will receive a great deal of Pleaſure, Madam, by reading what Dr. *Gregory* hath written about this Ring, in his Diſcourſe of *Saturn*, and in his *Comparative Aſtronomy*, ſo often recommended to you; where the moſt conſiderable Phænomena of this *Ring*, and of the *Satellites*, as they appear to an Eye ſuppoſed to be placed in *Saturn*, are explained and accounted for; or you may conſult the *Lexicon Technicum*.

I will, ſaid ſhe, attach myſelf heartily to that Book, as ſoon as I can: And after we have viewed this Planet with our Teleſcope, which I will ſit up any Time of the Night to do, if you can afford me your Aſſiſtance. For theſe two ſuperior Planets have ſo many Wonders attending them, that I grow ſeriouſly amazed; and long to underſtand a little more of them, and to contemplate theſe wonderful Works of our Great Creator. And indeed what a vaſt Field of Thought, what a new World of Speculation, do theſe new Diſcoveries open to us! How empty and ſtarved is a Mind unfurniſhed with ſuch glorious Ideas!

What a rich Fund of Images is treaſured up *here* to embelliſh our Poetry? And yet I do not remember to have met with many Alluſions taken from theſe Things, except in a late Copy of Verſes preſented to her Grace the Dutcheſs of *Bolton*, where, after the Poet had ſaid a great many fine and juſt Things of her, I now remember theſe Lines; the Beauty and Propriety of which, did not at firſt ſtrike me ſo much as they do now, ſince I have been converſant with theſe Speculations.

Bolton's the Center of Reſpect and Love;
Round her, like Planets, we at Diſtance move:
From her receive our Light, derive our Heat,
And ſtill tow'rds Her we tend and gravitate,
Juſt in Proportion to our *Senſe* and *Weight.*

But now, Sir, ſaid ſhe, if you pleaſe we will leave off, *unbend*, and go to our Tea.

The Lady plied her Teleſcopes, and purſued her Aſtronomical Studies with great Application and Succeſs; and after ſome Time, when I had the Honour to wait upon her again, ſhe took me out into the

Summer-houſe in the Garden, and then began thus with me.

Sir, ſaid ſhe, you have already taken a great deal of Pains to gratify a Woman's Curioſity; but I muſt beg you to indulge me yet a little further, and to afford me a Lecture upon another Point; about which, as I am aſhamed to trouble you, ſo I ſhould be afraid to aſk you, but that you have been ſo kind already, as to help me to get rid of many Fears and Terrors, too incident to our Sex: And if you can eaſe my Mind of this remaining Dread, I ſhall think you can do me a ſignal Piece of Service.

You muſt know I have been tumbling over thoſe Book of Aſtronomy, which you have bid me read; and though there be very many Things that I do not underſtand fully at preſent, yet there are ſome alſo that I know enough of, to be put into the Vapours by them.

The *Affairs of Comets*, Sir, with their griſly *Beards* and horrid *Tails*, fright me almoſt out of my Wits: For God-ſake, therefore, tell me, as plainly as you can, whether my Dread is well-grounded; Do they really *forebode* all Manner of Miſchief to Mankind, as well as *do* a great deal, when they come among us? What are they? Are their Motions natural, and accountable by Mathematical Calculation, as thoſe of the Planets? Or are they miraculouſly ſent hither as the Meſſengers of God's Wrath, and as the Executioners of his Judgments upon ſinful Mankind?

Madam, ſaid I, as to their *Preſages*, I take them to be entirely groundleſs; but they may be made (as almoſt any other of the Heavenly Bodies may, if God pleaſes) to become the Inſtruments of Evil and Deſtruction to any of the other Planets: But indeed it doth not plainly appear, ſince their Motions and Appearances have been of late more fully enquired into, that they *have any ſuch deſtructive Uſe*, or that they have actually done any real Miſchief in the Planetary World. There have indeed been ſome ſuch *Conjectures*; but as I take them to be *no more*, I will not trouble you with them now; becauſe I believe they will occur to you in your future Purſuit of theſe Studies.

I am glad to hear you ſay ſo, ſaid ſhe, and I begin a little to be comforted: But pray go on, and compleat my Cure; for I do not care to be *drowned* or *burnt* by one of theſe extravagant Ramblers, a Comet, before I am aware.

O Madam, ſaid I, I perceive where you have been dipping; I will therefore give you the moſt ſatisfactory Account I can.

The Ancients, you muſt know, generally believed *Comets* to be only *Meteors*, like our *Firedrakes*, *&c.* and that they were no higher than our Regions of the Air; while ſome modern Writers placed them among the fixed Stars. But ſubſequent Obſervations, with good Inſtruments, and the Application of the Laws of Motion and Geometry, to Aſtronomical Enquiries, have now ſatisfied us almoſt to a Demonſtration, that they are a *Kind of Planets* revolving in determinate Periods round the Sun: But indeed the Orbits of many of them are ſo very oblong, *exentric* or *oval*, as well as large and extended, that they can appear to us but very ſeldom; and when they do become viſible, they exhibit Appearances which are very ſurprizing; for the lower Ends of their Orbits are ſo very near the Sun, that when they come down into that Part, or into their *Perihelion*, as it is called, they are actually heated and ſet on fire by him to ſuch a Degree, as not to get off again, without ſuch dreadful *Beards* and *Tails*, as would really fright ſuch as do not underſtand and conſider how they come by them.

Bleſs me! ſaid ſhe, why then if our Earth moved in ſuch an Orbit, I ſee we might be eaſily deſtroyed and burnt up, by that very Sun who now gives us cheering Light and kindly Heat!

It is very true, Madam, ſaid I; for that great Comet which appeared here in the Year 1680, (and which I ſaw, and very well remember, though then but a Boy) went ſo near to the Sun, as to acquire a Degree of Heat above 2000 Times as great as that of red-hot Iron: And if it's Body was about the Size of our Earth, as it was judged to be, it would not be cool again this Million of Years. And yet it pleaſed God, that that Comet went away from us, without doing us any ſenſible Harm, that I know of; and ſo little do I fear being hurt by any of them, that I could almoſt wiſh another would appear, to help us to complete the Theory of their Motions.

Nay, ſaid ſhe, if you that know ſo much of them are not afraid of them, I am ſure I will not be ſo for the future: Pray, therefore, Sir, proceed, and tell me what you can of the Number, Motions, and Appearances of theſe Comets, how their *Beards* and *Tails* are formed; and how you account for the moſt eminent of their Appearances.

Madam, ſaid I, there have within this laſt 400 Years appeared to this Part of the World but 24 Comets, (how much greater a Number there may be, God knows, and perhaps ſubſequent Obſervations may diſcover more.) And of theſe, according to the Obſervations of Dr. *Halley* and other Aſtronomers, *three* of them have had their Orbits and Appearances ſo *very like*, and the Times of their Appearing ſo very *equal*, that the have judged it very probale that thoſe three Comets, which ſucceſſively appeared as three, were in reality but one or the *ſame Comet* appearing at three ſeveral Times.

And the like they are inclined to judge of two others, that they alſo are but one, appearing at two different Times.

The great Comet that appeared here in the Years 1680, and 1681, was ſeen before in our Hemiſphere, *A. D.* 1106; once before, about the Year 532; and alſo 44 Years before our Saviour's Birth: And therefore they conclude the Time of it's Periodic Revolution round the Sun to be 575 Years *.

The Time of the Revolution of *another Comet*, which they judge will appear again *A. D.* 1758, is 75 Years: *Another*, which probably may be ſeen here again, *A. D.* 1789, makes it's *Ellipſis* round the Sun in 129 Years.

What Bigneſs do you take theſe Comets to have been of, Sir? ſaid the Lady.

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* The Orbits of theſe three are deſcribed in Fig. 4.

Madam, ſaid I, they are generally of the Size of the reſt of the Planets, and have Atmoſpheres about them like our Earth: But then as all our Planets move pretty nearly in the *Plane of the Earth's Ecliptic*, theſe *Comets* are tied to no ſuch Rules; for the *Planes of their Orbits* have very different, nay, almoſt all Manner of Directions and Poſitions, and their Motions are all Manner of Ways; ſome from Eaſt to Weſt, others from Weſt to Eaſt, ſome from South to North, and other a quite contrary Way, *&c.* And yet their Motion is equable enough, and ſhews us this great Point; that as there can be no ſuch ſolid Orbs as was imagined in the *Ptolomaic Syſtem*; ſo there can be neither any ſuch thing as a *Plenum*, and no ſuch *ſubtile Matter* as the *Carteſians* have invented, to ſolve there *Hypotheſis*: But we may fairly conclude, that all the vaſt Spaces both between and beyond the Planetary Syſtem, are filled with no Matter capable of making any conſiderable Reſiſtance to their Motions, but rather are an immenſe Void, or Vacuity.

I think that is a very probable Concluſion, ſaid ſhe; for if there were any Quantity of reſiſting Matter, it muſt always obſtruct a little, and by Degrees muſt make very ſenſible Alterations in the Planets' Motions; which I do not find to have been in Fact diſcovered; but ſure, Sir, theſe Comets muſt go off to vaſt Diſtances from the Sun?

Yes, Madam, ſaid I, and therefore they are ſtill more unfit than any of the other Planets, to be inhabited by ſuch Kind of Being as thoſe of human Race; for the middle Diſtance of the Great Comet that appeared in 1680, was more than 5000 Millions of Miles from the Sun; as it's greateſt Diſtance was above twice as much, and yet it's leaſt Diſtance was not above a 20,000th Part of it's greateſt; ſo that in it's whole Revolutions, it would be ſubject to ſuch Extremities, as that it's *greateſt* Degree of Light and Heat to it's *leaſt*, were above 400 Millions to one. And yet notwithſtanding this immenſe Extenſion of it's *Ecliptic Orbit*, the Great and All-wiſe Architect of the Univerſe hath probably ſo adjuſted the *Centrifugal* and the *Centripetal*

Forces, that it doth not quite leave the Sun, though it go ſo far from him, but returns again towards him, and revolves round him in a determinate Period of Years. *None of the Orbits* of any of theſe Comets yet known, are in or near the Plane of the *Earth's Ecliptic*; and therefore in their *Aſſent* from the Sun though heated never ſo much by him, yet they will not come near enough to our Earth to *burn* us, or affect us with any ſenſible Heat; and therefore, Madam, your Fears of being *burnt in your Bed* by a Comet, I hope will vaniſh for this Time.

Well, ſaid ſhe, and ſo they will; but I love to know the Reaſons of Things as well as any Man of you all. But pray, Sir, what are the *Heads*, *Beards*, and *Tails* of theſe Comets?

Madam, ſaid I, the Bodies of Comets are probably in Subſtance like our Earth; fixed, ſolid, and compact: Their Tails are probably long and very thin Trains of Smoak and Vapours, emitted from the heated or enkindled Body, Head, or *Nucleus*, as ſome call it, after their *Perihelion*, or after their having been at their neareſt

Diſtance to the Sun; for then it hath been obſerved, that the *Tails of all Comets* have appeared *largeſt* and *longeſt*. In the *Lexicon Technicum*, under the Word *Comet*, you will find a great deal ſaid about the *Phænomena* of *Comets*, their *Beards*, *Tails*, &c. from Sir *Iſaac Newton*, and other Authors; and there you will likewiſe find Conjectures about their Uſe in the Planetary Syſtem.

Sir, ſaid ſhe, I ſhall have recourſe to thoſe Books with a great deal of Pleaſure, and will trouble you no farther now with my Enquiries: I ſee Company appearing, let us forget our Aſtronomy a while, and trifle with them as agreeably as we can.

About a Month after our laſt Conference, I waited on the Lady in *London*, who after the uſual Compliments, began thus with me.

Though you might be juſtly afraid to meet ſuch a queſtionary Creature as I am, I will own, I am glad to ſee you in this Place; for I have a great many Things to enquire of you, with relation to our late Conferences in the Country. Ever ſince that, I have been tumbling over Aſtronomical Books with the utmoſt Application; I have dipt a little alſo into the *New Phyſics*, and I have been running over *your* Geometry, *your* Trigonometry, and *your* Spheric Projection, in order to uſe my ſelf to Figures, and to get clearer Ideas of what the Aſtronomical Writers ſay: And though I believe I ſhould have been frighted and deterred from beginning with *Geometry*, and the *abſtracted Mathematics*, yet now I find them ſo neceſſary, that I am reſolved to try at them, and will beg your Help, when your Leiſure will permit. But in the mean Time pray tell me, Do not you think that the *Elementary Mathematics*, and the *Newtonian Phyſics*, or *Natural Phyloſophy*, might be taught to Gentlemen, or even to our Sex, in the eaſy and delightful Way you have inſtructed me in Aſtonomy?

Doubtleſs, ſaid I, Madam, there is no one *really* Maſter of any Science, but he can communicate it to another in plain and eaſy Words, and render it intelligible to any common Capacity and inquiſitive Genius.

Why then, ſaid ſhe, if I have any Power or Influence over you, which ſometimes you compliment me with believing, I would deſire you by all Means to attempt that, as your Leiſure will occaſionally permit you, and in the Intervals between your ſeverer Studies; for I really think it would be of the greateſt Uſe and Advantage, not only to our Sex, but even to your own: And I am ſatisfied too, that many of our young Gentlemen grow vicious chiefly becauſe they are idle, and having been taught nothing to improve their Minds, can have no Notions of the Rapturous Pleaſures of Science.

I entirely agree with you in you Notions, Madam, ſaid I, and your Commands ſhall be my Delight as well as my Duty; In the mean Time, can I ſerve your Ladyſhip in any thing now?

You are very obliging, ſaid ſhe, to anticipate your Trouble; but we will loſe no Time in Compliments: What I want at preſent, is, to be inſtructed farther by ſome *Diagram or Figure*, how by the Earth's revolving round the Sun in her Annual

Motion, together with *that* round her *Axis*, the different Seaſons of the Year, Length and Decreaſe of Day and Night, *&c.* are accounted for. Have you drawn me ſuch a Scheme as you once promiſed me, for this Purpoſe?

I have, Madam, ſaid I, and here it is; I took it chiefly from Mr. *Flamſtead*'s *Doctrine of the Sphere*; a Book, I dare ſay, your Ladyſhip will one time or other dip into.

I have ſeen it, ſaid ſhe, in Sir *Jonas Moor's Mathematics*, and perhaps may conſider it further; for though I never deſign to attempt the Calculation or Conſtruction of Eclipſes, yet I ſhall be glad to know how the Aſtronomers do it. But, pray, Sir, go on, and explain the Figures to me.

An Explication of Fig. V.

LET the Circle A B C D repreſent the Earth's Annual Orbit round the Sun, whoſe Center is ſuppoſed to deſcribe that Periphery, as it moves round the Sun from A towards B, in the Natural Order of the Signs, and from *Aries* to *Taurus*, &c.

The Line ♈, ☉, ♎, repreſents the *Equinoctial Colure*, and the other ♋, ☉ ♑, ſtanding at right Angles to it, is the *Solſtitial Colure*.

The four leſſer Circles *d o t i* repreſent the Earth's quadruple Poſition in the four *Cardinal Points*, as they call them, *i. e.* at the two Equinoxes, and the two Solſtices, and the Line *d t* at right Angles to the Colures, may fitly enough be called the *Horizon of the Earth's Diſk*, becauſe it ſeparates that half Part of the Earth which the Sun ſhines on, from the other which lies behind in the Dark.

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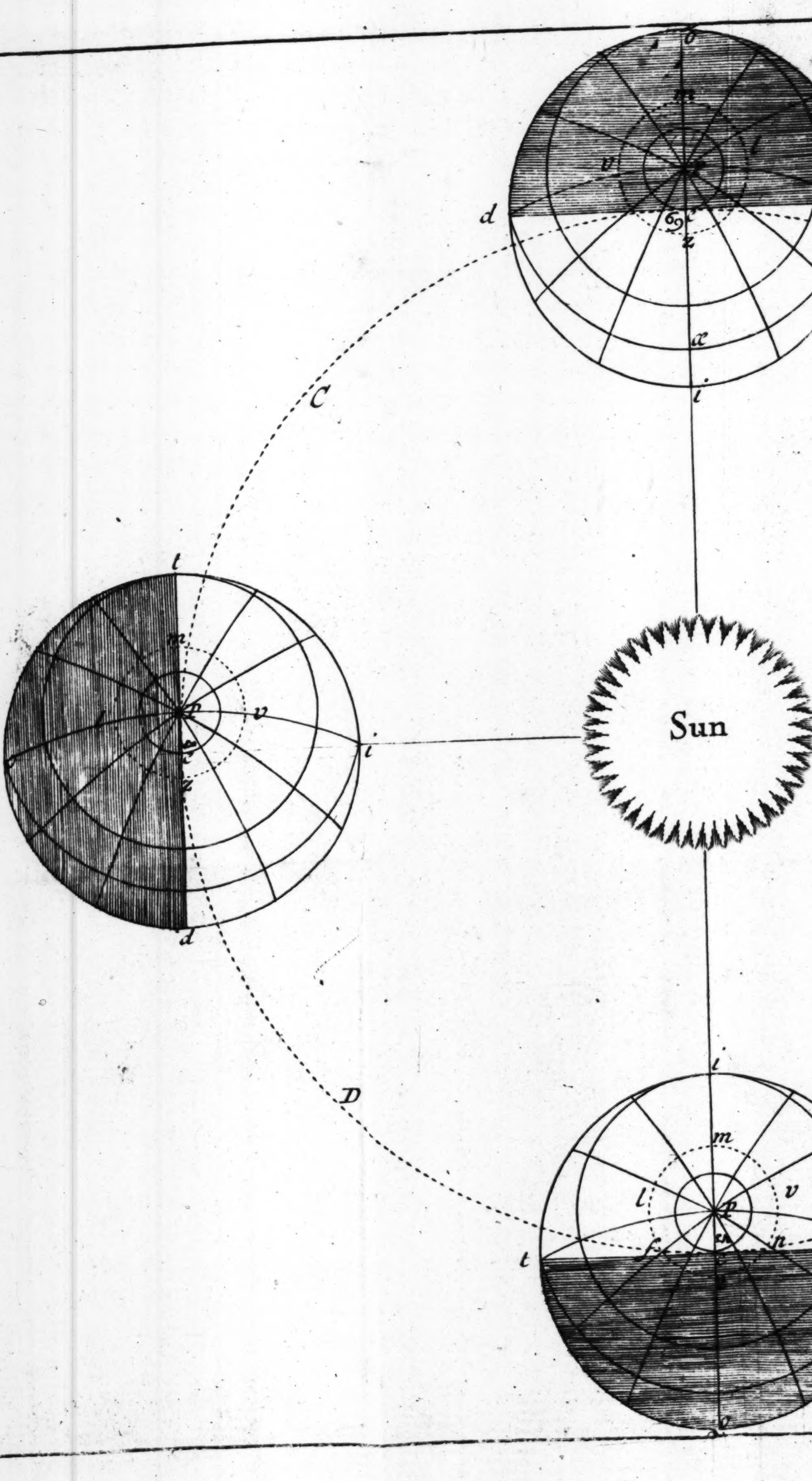
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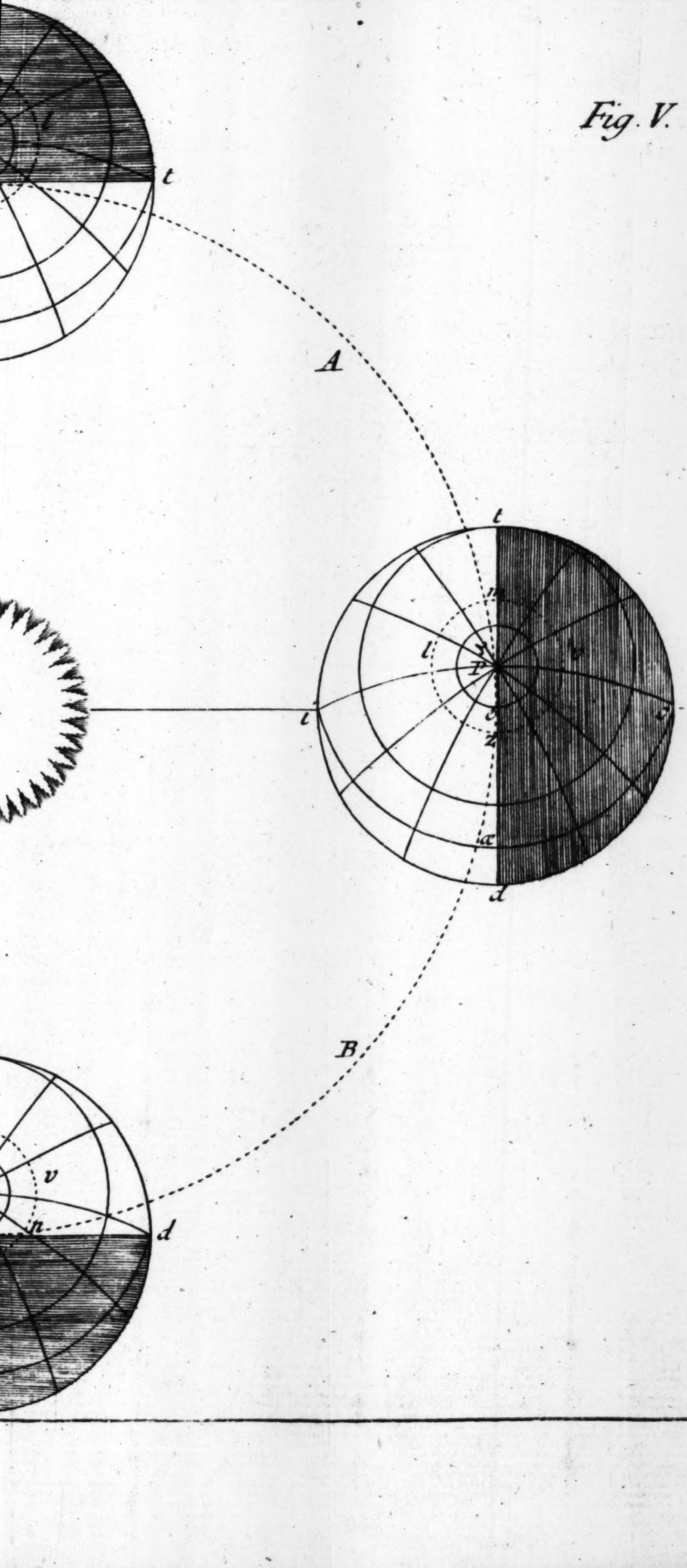
P. 174

Fig. V.



But, pray, ſaid ſhe, what do you mean by the Earth's *Diſk*.

I uſe the Word, Madam, ſaid I, becauſe you will frequently meet with it in your Reading; it ſignifies that round Appearance of the Sun, Moon, or Earth, which we ſuppoſe to be the Object of any Spectator's View; and therefore the Earth's Diſk is the Appearance of that half of it, which becauſe it is enlightened by the Sun, is ſeen by any remote Beholder.

Very well, Sir, ſaid ſhe, pray go on.

In theſe four Figures of the Earth, the Spectator's Eye is ſuppoſed to be below under the Earth's Center *e*, which Center always moves in the Circle ABCD. To an Eye ſo placed, the Circle *d o t i*, which divides the Earth's Upper Hemiſphere from the Lower, will appear to lie in, or be *coincident* with, the *Plane* of the *Ecliptic*; and therefore that may be called the *Ecliptic on the Earth's Globe.*

The *North Pole* of the Earth, or the upper End of the *Axis*, about which her

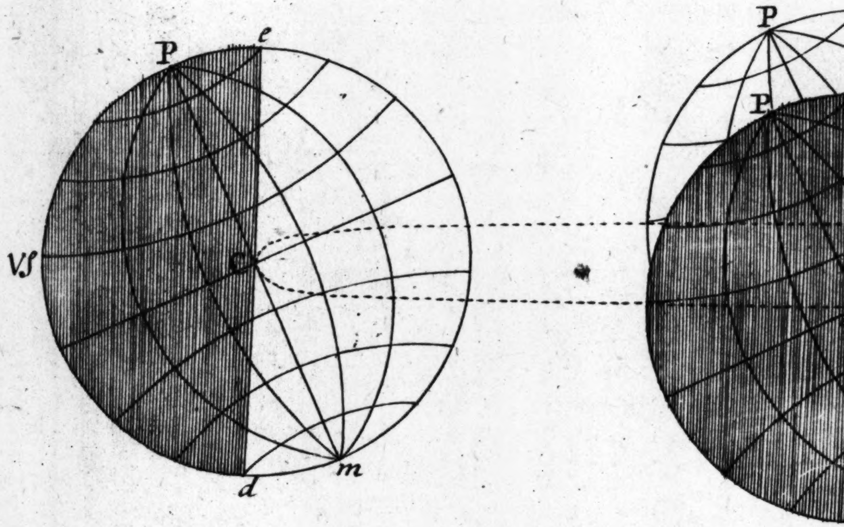
Diurnal Motion is made, will then appear to be at *P*, 23° 30′ diſtant from *e* to the Pole of the Ecliptic; and if you draw a Line through thoſe Points connecting the two Poles, that may be called the Line of *Direction of the Earth's Axis*; and if produced, it will be coincident with, or parallel to, the great *Solſtitial Colure*, and therefore will deſcribe *ſuch a Line* on the Earth, to which, when the Sun's Rays run parallel, or whenever the Earth's Center is in the Points ♑ or ♋, then will the *longeſt*, in the latter, and the *ſhorteſt Days*, in the former Caſe happen to all the Inhabitants of the Earth.

This Line of Direction *P e*, is always found parallel to the Line ♋, ☉, ♑, during the whole annual Revolution of the Earth.

Pray ſaid ſhe, what occaſions this *Paralleliſm of the Earth's Axis?* which I have read much of

Madam, ſaid I, it is not any *new Motion*, ſuperinduced into the Earth, but only her keeping to the firſt Poſition or Direction of that Diameter about which ſhe revolves; which ſhe muſt always do, without it be changed

Fig. VI.



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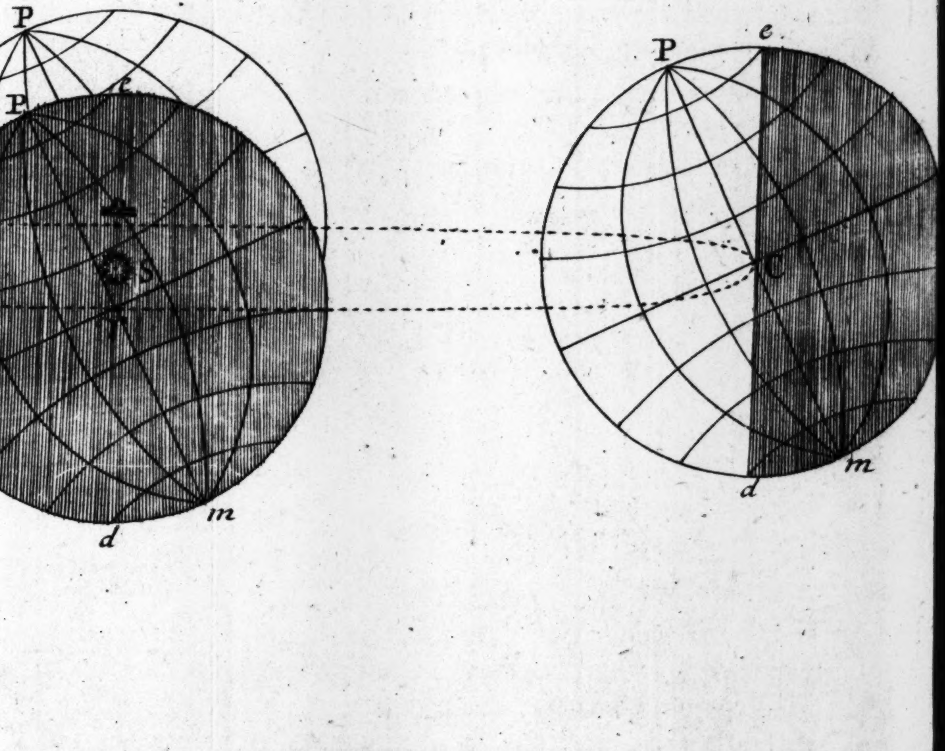

changed by the Will of the Great Creator, who at firſt appointed it to be ſo as it is. But if you pleaſe, I will go on.

A Line drawn perpendicular to the Earth's Axis will repreſent on the Earth the *Equinoctial Colure*, and will always be parallel to the Great Equinoctial-Colure, ♈, ☉, ; and whenever the Sun's Rays run parallel to this Line, which they will do, whenever the Earth is in ♈ or ♎, then will the *Days and Nights be equal* all the Earth over: For you ſee that as the Earth revolves round it's Axis *t P e d*, all Circles deſcribed on the Earth, from the Pole *P*, *i. e.* ſuch as are the *Equator* and all it's Parallels, will be juſt one half in the Light, and the other half in the Dark.

The Angle made between the Earth's Axis and that of the Ecliptic, may be learnt beſt from *Fig.* VI.

In which the Ecliptic Line ♈ C ♎ C repreſents the Earth's Annual Orbit, as viewed by the Eye, at a vaſt Diſtance, and when the Eye is placed a little above it's Plane: Here let *e* be the Pole, and *e d* be the Axis of the Earth's Ecliptic, which you muſt ſuppoſe to be every where at right Angles to the Plane of the *Great Orbit*; and let *P* be the Earth's North Pole, *P m* the Earth's Axis, about which the Earth turns from Weſt to Eaſt in 24 Hours; and ſuppoſe the Angle *P C e* to be always the ſame, *viz.* 23° 30′.

Theſe things being ſuppoſed, it will be plain, that every Point on the Earth's Surface, will, as the Earth revolves in her Diurnal Motion, deſcribe a Circle about the next Pole: And when you conſider, that every *ſuch Point* is *Vertical* to the Earth's Center, and anſwering to what hath uſually been called the *Zenith*, or *Vertex*, in the *Ptolemaic* Projections, the Circle ſo deſcribed is very properly called the *Path of the Vertex*, becauſe it is a Track or Line made by the Motion of that Point.

I fancy I ſhall conceive this right, ſaid ſhe, when I get to my Globe; for then if I bring *London* into the *Zenith*, the Point on the Globe repreſenting *London*, is I ſuppoſe what you call the *Vertex*; and if I turn the Globe round it's Axis, I ſee that Point will deſcribe a Circle, parallel to the

Equator; and ſuch a Parallel, I take it, you call the *Path of London.*

Exactly right, ſaid I, Madam, and no one could have explained it better. I think then, we ſhall now go on with pleaſure.

In ſuch Projections as theſe four Figures of the Earth in *Fig.* V. a Circle equally diſtant from both the Poles, muſt be the Earth's *Equator*; and the Diſtance of any Place from that Circle, will be the *Latitude* of that Place; and therefore half the Diameter of any *Path* will be the Sine Complement of the *Latitude* of any Place deſcribing that Path.

If you take any Place on the Earth, and make a Circle paſs through it, and the two Poles, that will be the *Meridian* of that Place.

That Point in the Earth's Periphery. which is oppoſite to the Sun, or which is found by a right Line drawn from the Earth to the Sun, is called the *Sun's Place in the Ecliptic.*

i P o, and *t P d*, in *Fig.* V. repreſent the Earth's firſt Meridian, in each Pair of the oppoſite Circles.

m a z l, repreſents the Circle made by the *Vertex* of *London*; as that within doth the *Northern Polar Circle*; and the next without it, the *Northern Tropic.*

By the Figure it will appear plain, that ſince the Sun enlightens but one half of the Earth's Globe at a Time, if the Earth be in ♎ or ♈, the *Horizon of the Diſk* will then coincide with the *Solſtitial Colure*; and therefore as the Earth turns round her *Axis*, which now is coincident with the Line *d t*, the Paths of the *Vertices*, or the Equator, and all it's Parallels will be biſſected by the Line *d t:* And while any particular Place on the Earth, or ony *Vertex* is in the Light Part *t i d*, the Inhabitants of it will ſee the Sun; and therefore to them it will be *Day:* And while it is in the Dark Part, it will be *Night* to them.

But when the Earth is moved on, either from ♎ to ♋, or from ♎ to ♑, the *Line of Direction* will coincide with the *Solſtitial Colure*

Colure, and the *Horizon of the Diſk* will become at Right Angles to it on the Pole of the Ecliptic *e*. Wherefore, when the Earth is in ♑, all Places between the two Poles of the Earth and the Ecliptic, and the *entire Arctic Circle*, will, now you ſee, be illuminated in their whole Revolutions, as the Earth revolves round it's Axis *i P o*. The *Vertexes* therefore will ſee the Sun, each one longer than 24 Hours, according as it is more or leſs diſtant from the Pole of the Globes; and thoſe that lie under the *Arctic Circle*, touch the *Horizon of the Diſk*; and conſequently at this Time of the Year, *viz.* *June* 10, they will ſee the Sun 90 Degrees from the *Vertex*, both on the North and South of their Meridian; ſo that as ſoon as he is Set, will immediately Riſe again; and conſequently they have no Night: But all *Paths* without this, you ſee, do *cut*, or get within the *Horizon of the Diſk*; and ſo will have their Days longer than their Nights, in proportion to the Quantity of the enlightened Part of their Path, to the dark one; *i. e.* at *London*, as the Ark *n v m l f*, is to the Ark *n z f*; which is above Two to one; and therefore the Days will then be above 16 Hours long, and the Nights ſcarce 8.

Again, while the Earth moves from ♎ through ♑, and ſo on to ♈, you ſee the *North Pole* of the Earth is all that Time in the light Part of the Diſk; which ſhews you, that to ſuch as live under that Pole there will be 6 Months Day. But while the Earth runs on from ♈ through ♋ to ♎, that Pole will, you ſee, be in the dark Part of the Diſk; which ſhews that then, under the Poles, there will be 6 Months Night. For indeed, when the Earth is in ♋, all Things will be the very reverſe of what they are when ſhe is in ♑; *i. e.* the Nights longer than the Days, *&c.*

But when the Earth is in ♈ or ♎, the Axis of the Earth's Revolution being *d t*, (the *Horizon of the Diſk*) juſt one half of the Equator, and all it's Parallels will be enlightened, and the other half in the Dark; and therefore the Days and Nights muſt be equal all the World over.

Sir, ſaid the Lady, if you can part with this Figure, I will look it over more carefully another Time when I am by myſelf. In the mean Time I have another trouble to give you, if you will oblige me in it; and that is, to get me a ſight of the famous *Orrery*, which I have heard you and others ſo often ſpeak of; and which I think was made by Mr. *Rowley*, the famous Mathematical Inſtrument-Maker, and Maſter of the Mechanics to the King; and whom I find you have always recommended in your Books, as the beſt Workman of his Profeſſion.

I ſhall ſtay in Town about a Week longer, and will enlarge my Time a Day or two rather than miſs ſeeing ſo inſtructive and curious a Piece of Ingenuity.

Madam, ſaid I, the *fine Inſtrument* of that Name, which Mr. *Rowley* made for the *Eaſt India* Company, is now luckily in a Place where I can come at it; I will go thither to-morrow, and then appoint you a Day when I will wait on you to ſee it.

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☉ *The Sun.*
E *The Earth.*
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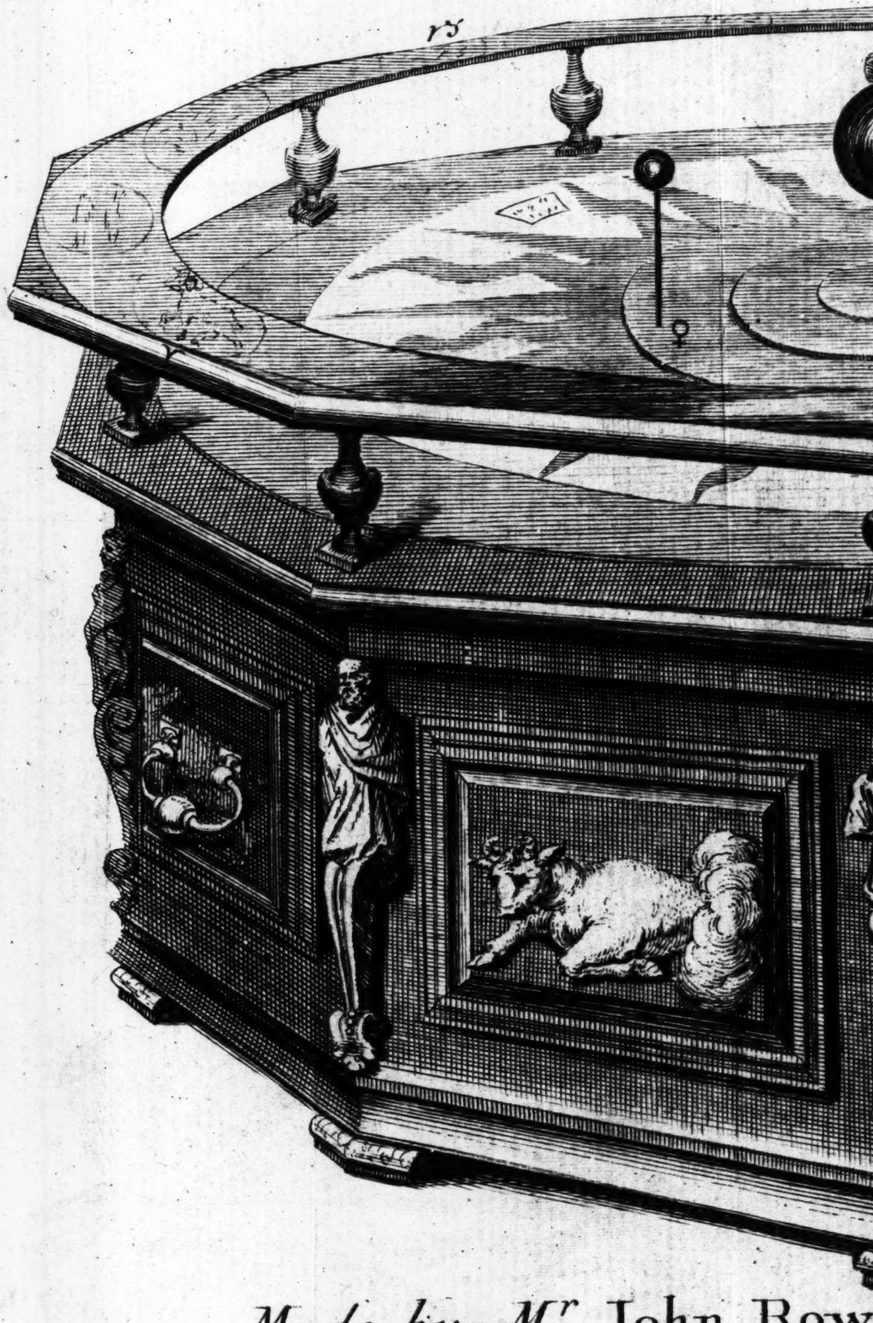

Made by Mr. John Row

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♈ ♋ ♎ ♑
The Eccliptick

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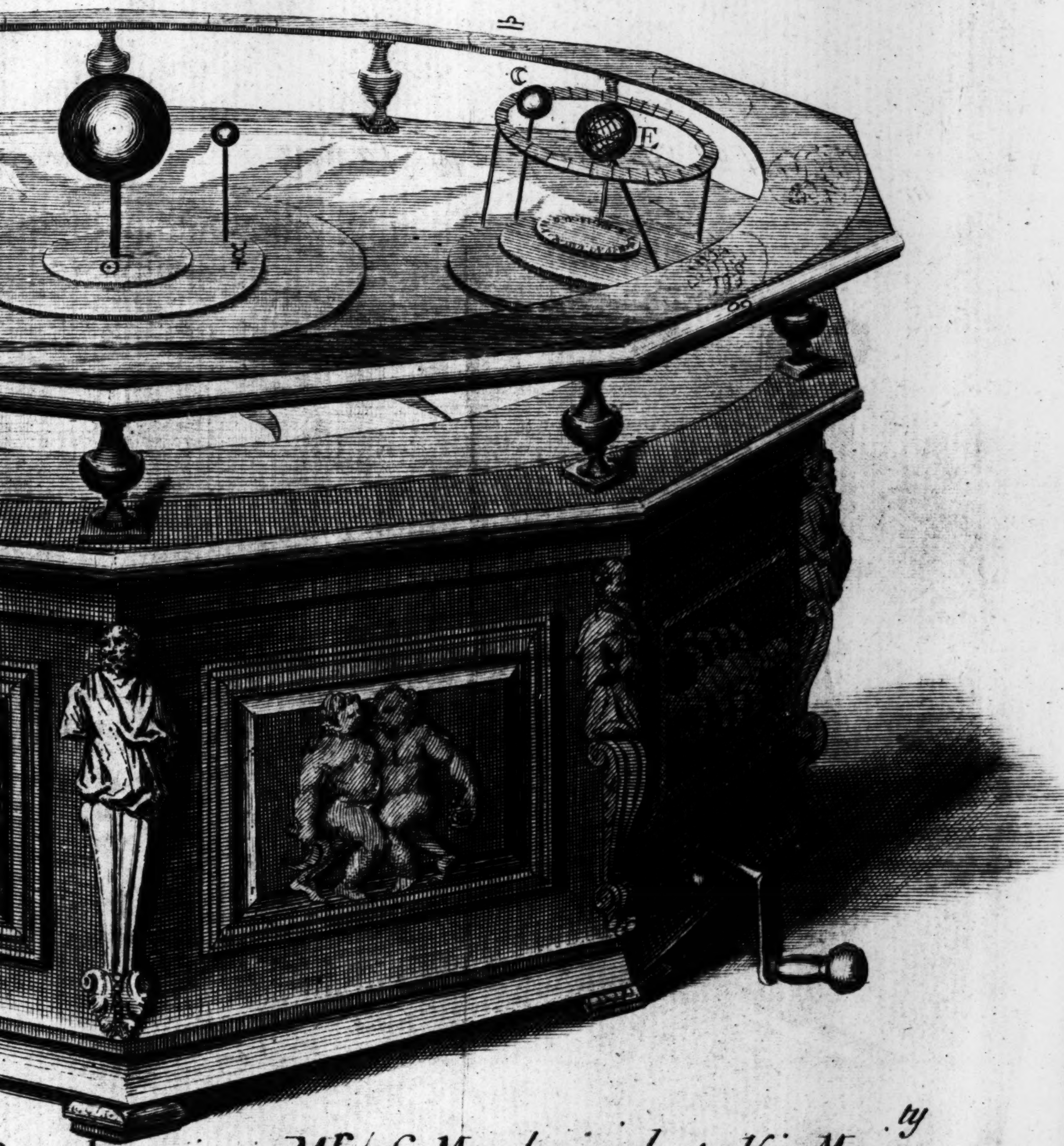


Rowley *Mr. of Mechanicks to His Majty*

THE

DESCRIPTION

OF THE FAMOUS

INSTRUMENT

CALLED THE

ORRERY:

MADE BY

Mr. JOHN ROWLEY,

Maſter of the Mechanics to the KING.

THE DESCRIPTION OF THE FAMOUS INSTRUMENT CALLED THE ORRERY.

WITHIN a Day or two, I obtained for the Lady a Sight of the ORRERY; ſhe deſired we might have no other Company but one young Lady more of her Acquaintance; becauſe, ſaid ſhe, I ſhall aſk ſo many Queſtions, as perhaps will ſhew my *Impertinence* to thoſe who are not acquainted with Things of this Nature, and my *Ignorance* to thoſe who are.

As ſoon as the Inſtrument was taken out of it's Caſe, and ſet upon the Table, ſhe expreſſed herſelf mightily pleaſed with the

Cleanneſs and Cleverneſs of the Workmanſhip of it; for indeed the Outſide of it is very rich and beautiful. The Frame is of fine Ebony richly adorned with twelve Silver Pilaſters, in the form of *Cariatides*; and with all the Signs of the Zodiac, caſt of the ſame Metal, and placed between them; the Handles were alſo of Silver finely wrought, with the Joints as nice as ever were ſeen in the Hinges of any Snuff-Box: On the Top of the Frame, which was exactly circular like the Horizon of a Globe, is a *broad Silver Ring*, on which the Figures of the twelve Signs are exactly engraved; with two Circles accurately divided; *one* ſhewing the Degrees of each Sign, and the *other* the Sun's Declination, againſt his Place in the Ecliptic, each Day at Noon.

The Nature and Uſe of theſe Circles the Lady perfectly underſtood, from what ſhe had before learned; and therefore in her pleaſant way, ſhe began thus:

If ſo much Art and Expence be beſtowed upon the *Outſide* of this curious Machine, I do not doubt but the *Inſide* of it is at leaſt equally curious and uſeful: And therefore I muſt deſire you, Sir, ſaid ſhe, to begin quickly, and to ſhew it all to me, as the Man doth the Tombs at *Weſtminſter*; though I hope you will not be always in the ſame Haſte, nor imitate his precipitant Manner, and aukward Tone of Speech: But do it ſlowly and diſtinctly, allowing me Time to think and conſider about it, and to aſk you all the Queſtions I have a mind to.

Madam, ſaid I, you know you can determine and command me, as you pleaſe.

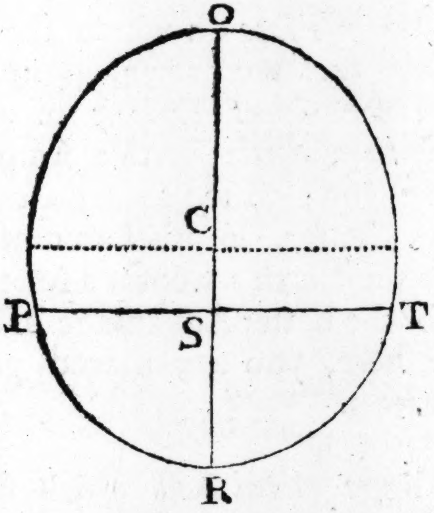
This *Silver Plate* on which the Signs of the *Zodiac*, &c. are drawn, repreſents the Plane of the *Great Ecliptic* of the Heavens; or *that* of the Earth's Annual Orbit round the Sun; which as it paſſes through the Sun's Center, ſo it's Circumference is made by the Earth's Center's Motion; and which for the better Advantage of View and Sight, is here, you ſee, placed parallel to our Horizon.

The large *gilded Ball* which ſtands up, you ſee, here in the middle, not *upright*, but making with the Plane of the Ecliptic an Angle of about 82 Degrees, is ſo placed to repreſent the *Inclination of the Sun's*

Sun's Axis; and which being pretty near the Center of this Orbit, repreſents the Sun.

Pretty *near*, ſaid ſhe; why is not the Sun then exactly in the Center of that Circle, which you call the Earth's Orbit?

No, Madam, ſaid I, nor is that Orbit exactly a Circle; but an *Oval* or *Ellipſis*. As in this Figure which I will now draw with my Pencil and ſhew you: Let the



Curve Line PORT repreſent the *Orbit* of the Earth revolving round the Sun, which is placed not in C, the Center, but in S, a Point in the longer Diameter, which they call the *Focus:* The Diſtance between C and S is what in the *Ptolomaic Syſtem* was called the *Eccentricity*, and expreſſes how much the Earth's Orbit differs from being a true Circle. And the Contrivance of this Inſtrument is ſo admirable, that you will ſee by and by, when I ſet it a-going, this *Eccentricity*, and that of the other Planets, will be plainly ſhewn to your Eye, in the ſame Proportion as they are in the Heavens.

Pray, Sir, ſaid ſhe, go on; I find I ſhall come to underſtand this better, when I come again to read Dr. *Gregory*, and Mr. *Whiſton.*

Madam, ſaid I, you ſee here two *little Balls* ſtanding upon two Wires, at different Diſtances from, but pretty near, the Sun; the innermoſt of theſe is deſigned to repreſent *Mercury*, the other *Venus.*

But why are they placed, ſaid ſhe, upon thoſe two Wires; they ſtand perking up like the Traitors' Heads upon *Temple-Bar*; I hope Mr. *Rowley* hath not diſcovered that they have committed any late Treaſon againſt their *Sovereign the Sun.*

No, no, Madam, ſaid I, they are very *Loyal Planets*; the Contrivance is only to bring their Centers to be ſometimes in, and always pretty near, the *Plane* of the great Ecliptic, (and, by the by, the Plane of their Orbit always paſſes through the Sun, and interſects the Ecliptic in two Points, which they call *Nodes*) and this Poſition is contrived in order to ſhew us what Appearances they do really exhibit in their ſeveral Revolutions round the Sun. For the ſame Reaſon you ſee the *Earth* and *Moon* here placed likewiſe on Wires or Pins, that their Centers may get ſometimes actually into, and always be pretty near, this Plane of the great Ecliptic; for ſo the Orbits of all the Planets are really placed in the Heavens.

I like that *pretty Ivory Earth* very well, ſaid ſhe, as I do the *Golden Sun*: But, pray, why doth the Earth's Pin ſtand *inclining* ſo, and not *upright*?

Madam, ſaid I, that is to repreſent alſo the *Angle that the Earth's Axis*, or that of the *Equator*, makes with the Axis of the *Ecliptic*; which latter, in this Inſtrument, being perpendicular to the Horizon, the Earth's Axis is placed ſo as to make an Angle with the Plane of the Horizon of 66° ½; or dipping down from the Zenith juſt 23° 30′, which you know is the Angle made by the two Planes of the Equator and Ecliptic. And as the Earth in each of her annual Revolutions round the Sun, always keeps her own Axis parallel to itſelf; ſo you will ſee, by and by, when the Inſtrument moves, that this *Terella*, or little *Ivory Earth*, will do ſo too, as it takes it's Tour quite round the *Golden Sun* in this Inſtrument.

I long to ſee that, ſaid the Lady, very much; but I ſuppoſe I muſt ſuſpend my Inclinations, till you tell me it is fit they ſhould be gratified.

Madam, ſaid I, it is beſt to conſider the ſeveral Parts of the Inſtrument, firſt ſeparately or ſingly, and then the ſeveral Motions and *Phænomena* will appear in the better and more inſtructive Light: Therefore if you pleaſe, we will go on.

You obſerve, Madam, ſaid I, *another Wire* here, ſtanding cloſe to this Silver Circle, and which hath a *Ball* upon it, whoſe Center is in the Plane of that Circle: This is deſigned to repreſent the *Moon*; and the Silver Circle repreſents her Orbit round our Earth, the Plane of which always runs through the Earth's Center, and the Figures that are engraved upon it, ſhew her Age, from one New Moon to another.

Well! ſaid ſhe, this is mighty inſtructive! I long to ſee the Earth and the Moon move, but I know I muſt have patience: I ſuppoſe the Moon's Globe being *black* on one ſide, and *ſilvered white* on the other, is deſigned to repreſent her *Phaſes*, as they call them, of which you have ſhewed me ſomething before.

It is ſo, Madam, ſaid I; and you will ſee this Machine * ſo admirably contrived, that what I told you of the Moon's monthly Revolution, will ſhew itſelf to be in fact true here; for the *Lunula* here will turn round it's own *Axis*, at the ſame Time as it moves in this *Silver* Orbit round the *Terella*. And in reality, Madam, I cannot blame your Eagerneſs to ſee the Machine put into Motion, when I ſee how well you underſtand it, and know what it ought to do: And therefore you ſhall be detained no longer, than while I deſire you to take notice of this Hole in the great Braſs Plate that covers all the Movement, and of this moveable *Index* here on the Silver Ecliptic. You ſee there are on the former ſome Figures engraved; they are the common ſolar *Years*: and by taking the Inſtrument to pieces, it may be ſet to this preſent Time: And the Planets, by Means of an *Ephemeris*, may be ſet to any particular Time alſo. So that if a Weight or a Spring, as in a Clock, were applied to the *Axis* of the Movement, ſo as to make it move round once in juſt 24 Hours, theſe *Repreſentative Planets*, which you ſee here, would all perform their Motions round the Sun and one another, exactly in the ſame Order and regular Manner, as their *Originals* do in the Heavens; and this would then be a true *Celeſtial* or *Aſtronomical* Clock, which would ſhew the *Aſpects*, *Eclipſes*, and other Phænomena of the Sun and Planets, for ever. But becauſe this would be inſtructive only in that ſlow tedious way to ſuch as could have daily recourſe to it, Mr. *Rowley* hath contrived, by a Winch or Handle, to turn the Axis ſwiftly round about, and by that Means to ſhew all the *Phænomena* or Appearances in a very little Time, as you ſhall ſee I will now proceed to do; for by turning this Handle backward or forward, you may ſee what *Eclipſes*, *Tranſits*, &c. have happened in any Time paſt; or what will happen for any Time to come, without doing any Injury to the Inſtrument.

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* *Vid.* Figure of the *Orrery.*

I am amazed at the Thought and Contrivance of this Inſtrument, ſaid ſhe, and I doubt not, ſhall receive a prodigious Pleaſure when I ſee it put into it's proper Motions: But pray, Sir, let me firſt aſk you, *Are all the Planets here?*

No, Madam, ſaid I, (for I ſee nothing can eſcape your Ladyſhip's Diſcernment) here are only ſhewed the Orbits of *Mercury*, *Venus*, the *Earth*, and the *Moon*; for the others are at too great a Diſtance to be brought into the Inſtrument, if any tolerable Proportion be obſerved between it's Parts: And indeed, by what you will ſee of the Motion of theſe three Planets, and of the Earth's *Satellite*, the *Moon*, you will eaſily know what the *Phænomena* of the Superior Planets and of the other *Satellites* would be, if they could be here ſhewn; as they cannot well be without embarraſſing the Inſtrument with a vaſt Number of Wheels more: And it hath almoſt 100 already.

But now, Madam, I will fix on the Handle, and begin to put the Inſtrument in Motion.

One entire turn of the Handle anſwers to the *Diurnal Motion* of the Earth round it's *Axis*, as you will ſee by the Motion of the *Hour Index*, which is placed at the foot of the Wire on which the *Terella* is fixed; and which you perceive moves once round, as I now with my Hand turn the Spindle of the Machine round, after the ſame manner. You will take notice alſo, that the Inſtrument is ſo excellently formed, that I can make the Motion tend either way, forward or backward; and turn it about after the ſame manner, till I bring the Earth to anſwer to any Degree or

Point of the *Ecliptic*. As for inſtance, I will move it about till I bring the Earth to the firſt Point in *Aries*. Then you ſee, to an Eye placed on the Earth, the Sun will appear to be in the *Oppoſite Point*, that is, in the firſt of *Libra*.

But, Sir, ſaid ſhe, I perceive as you turn the Earth about, the Silver Circle on which the Moon's Age is placed, and which I think you ſaid repreſented her Orbit, *riſes and falls*: What is the meaning of that?

Madam, ſaid I, you know the Moon's Orbit is not exactly in the Plane of the Ecliptic; but makes an Angle with it of between 4 or 5 Degrees; and juſt ſo much this Circle riſes above and ſinks below the great Ecliptic, according as the Moon hath North or South *Latitude*, and juſt as *much* as that *Latitude* is: And you will obſerve *two little Studs*, which are placed in two oppoſite Points of this *Silver Circle*; they are deſigned to repreſent the *Moon's Nodes*, or the Points of Interſection of *her Orbit*, with that of the Ecliptic: Of which, more by and by.

O! pray move on, Sir, ſaid She, this is amazingly fine: I fancy myſelf travelling along with that little Earth in it's Courſe round the gilded Sun, as I know I am in reality with *that* on which I ſtand, round the *real* one.

You ſee, Madam, ſaid I, that one entire Turn of the Handle is, as I ſaid before a Natural Day: Now, if you pleaſe to take off *one of the broadeſt of your Patches*, and make it a *Spot* upon the *Golden Sun* there, you will ſee that your Patch will move quite round in 25 Days, or 25 Turns of this Handle; and that will ſhew you how by the Motion of the *Spots* in the *real Sun* the Aſtronomers diſcovered he had ſuch a Motion round his *Axis*, as you ſhall ſee Mr. *Rowley* hath given here to his *Repreſentative*.

Well, ſaid ſhe, ſince even my Patches muſt become Aſtronomical, I will ſtick one upon this *Fictitious* Sun; but I muſt own I do not love thoſe *Spots* upon the *Natural* one; nor to have any of his Face hid, or his Heat impaired: But ſhew me to what Part of the Sun this Patch is to be preferred.

Pleaſe to ſtick it, ſaid I Madam, juſt againſt the firſt Degree of *Aries*, and in the Middle of the Sun's Body. —— Very well! Now you will ſee that as 265¼ of theſe Turns of the Handle will carry the Earth quite round in the Ecliptic; ſo 88 will make *Mercury* perform his Revolution, and 244 Turns will make *Venus* move quite round the Sun.

Twenty-ſeven Turns and a little more than a Quarter of one, you ſhall ſee, will carry the Moon round in her Orbit; in which Time you will obſerve ſhe always turns the ſame Hemiſphere towards the Earth.

Take notice alſo, Madam, that now I have juſt made 12 Turns and an half, which hath carried your Patch to the oppoſite Part of the Sun.

And ſhall I ever ſee it again, ſaid ſhe; ſhall I ever recover the *Solar Traveller*?

Yes, Madam, ſaid I, you may have it again; but pray keep it for hereafter only for ſuch Uſes, and do not replace it on your Face; for I am as angry at *Patches* in a *good Face*, as you are at *Spots* in the *Sun*; and for *your* Reaſon, becauſe I would not have any Part of it hidden from me.

But the Handle goes on; a Turn or two more will have carried the *Moon* half round in her Orbit; obſerve how ſhe moves: It is now 25 Turns, you ſee, your Patch is come ſafe about to you; off with it.

No, ſaid ſhe, there it ſhall ſtick till we have done, ſince you will not have it be on my Face any more: I love dearly to ſee it turn round; and perhaps ſhould I put it on, it may make my Head turn quite round too, as I think it begins to do already without it: But pray turn on your Handle however.

Madam, ſaid I, at the End of twenty-ſeven Turns and a Quarter, you ſee I have made the Moon perform her Revolution round the Earth: *Mercury* is got about a third Part of his Way; and in ſeventeen Turns more will have finiſhed juſt half his Revolution. And *Venus*, you ſee, will then have advanced a fifth Part of her Way, in Proportion to the Magnitude of her Orbit: And the Earth alſo hath traverſed in the Ecliptic the Diſtance of above three Signs.

And by thus revolving the Earth and Planets round the Sun, you may bring the Inſtrument to exhibit *Mercury*, and ſometimes *Venus*, as directly *interpoſed* between the Earth and the Sun; and then they will appear as *Spots* in the Sun's Diſk, as I hinted to you before. And this Inſtrument ſhews alſo very clearly the Difference between what they call *Geocentric* and *Heliocentric* Aſpects, according as the Eye is placed in the Center of the Earth or Sun.

Well, ſaid ſhe, I have no Words to expreſs the Pleaſure and Satisfaction I receive from this moſt curious Engine, nor the Amazement the wonderful Contrivance of it gives me. Were my Fortune but half as great as my Curioſity, I would have one of theſe Inſtruments as ſoon as poſſibly I could get it, and then without being beholden to any of you *He-things*, I would turn it about myſelf, till I made it do all I had a Mind to. And I wiſh now, that I could ſee the Inſide of it; and underſtand what Numbers of Teeth and Pinions he hath made uſe of, to produce thoſe various Motions.

Madam, ſaid I, that cannot be done without the Hand of Mr. *Rowley* himſelf: But our moſt excellent King having the ſame Deſire and Curioſity as your Ladyſhip, he took it all to Pieces before his Majeſty, and to his great Satisfaction ſhewed him every Part of the Contrivance.

Well, ſaid ſhe, ſince I cannot have that Satisfaction now, pray proceed to let me know as much of it as you can.

Madam, ſaid I, you will next be pleaſed to ſee the Difference between the Moon's *Periodic* and *Sydonic* Month, and the Reaſon of it, very plainly here ſhewn to the Eye: I have now turned the Handle round till I have ſhewn you juſt ſuch a Period, as the Time between *our firſt*

New Moon, when the Earth was in the firſt Point of *Aries*, and the *preſent one:* And at the Earth's Place in the Ecliptic, where this happens, I will ſtick this Bit of Paper; and turning 27¼ Turns of the Handle more, you ſee I have brought the Moon again to be exactly interpoſed between the Earth and the Sun; and then you know it will be *New Moon* to us; but you ſee the Line of the *Syzygys* is not right againſt the Bit of Paper, but behind it; and it will require two Days Time, or *two Turns* more before it will get thither.

I think the Reaſon of that, ſaid ſhe, appears here very plain; becauſe in this 27 Days the Earth advances ſo far forward in her annual Courſe, as is the Quantity of the Difference in Time between the Moon's two Months. But pray, Sir, ſaid ſhe, will not this naturally carry you to ſhew me how the Eclipſes are formed?

Yes, Madam, ſaid I, and that is all which is material, that I have left to ſhew you.

You know, Madam, the Aſtronomical Books tell you there can be no Eclipſe of either Sun or Sun or Moon, but when the Moon is in or near the *Nodes:* And this will be here very plainly ſhewn to you by the Means of this Thread, of which if you pleaſe to take that End, we will extend it ſo as to repreſent the Line of the *Syzygies:* I will turn the Handle about till the next Conjunction of the Moon comes to be in or near the *Node*, or in the Plane of the *Ecliptic*: and then you ſhall ſee there will be an *Eclipſe of the Sun.* You ſee I have turned the Handle about 27 Times; but now the Centers of the Sun, Earth, and Moon are not near in a Right Line, as the Thread ſhews you; and therefore there will be no *Eclipſe of the Sun:* But you ſee now at the *Full Moon*, the Line connecting the three Centers, is very near the *Node*; therefore there will be an *Eclipſe of the Moon:* And * now you ſee there is an *Eclipſe of the Sun*; which is *Central*, when all the *three Centers* abovementioned come into this Thread thus ſtretched in the Plane of the *Ecliptic*; and *Total*, when the Moon is in her *Perigæum*, at the greateſt Diſtance from the Sun, and neareſt to us.

---

* *After I had turned it round ſeveral Times till it happened ſo.*

But in order yet farther to ſhew the *Solar Eclipſes*, and alſo the ſeveral Seaſons of the Year, the Increaſe and Decreaſe of Day and Night; and the different Length of each in different Parts of our Earth, Mr. *Rowley* hath this further elegant Contrivance.

He hath provided this little Lamp to put on upon the Body of the Sun; which caſting, you ſee, by the Means of a Convex Glaſs, and the Room made a little dark, a ſtrong Light upon the Earth; will ſhew you at once all theſe Things: firſt how *one half* of our Globe is always illuminated by the Sun, while the other *Hemiſphere* is in the Dark; and conſequently, how Day and Night are formed, by the Revolution of the Earth round her *Axis*; for ſhe turns from *Weſt* to *Eaſt*, ſhe makes the Sun appear to move from *Eaſt* to *Weſt*. And you will pleaſe to obſerve alſo, Madam, that as I turn the Inſtrument about in order to ſhew you the ſeveral Seaſons of the Year, and the Length and Decreaſe of Day and Night, how the Shadow of the Moon's Body will cover ſome Part of the Earth, and thereby by ſhew you, that to the Inhabitants of that Part of the Earth there will be a *Solar Eclipſe.*

That is exceeding plain and inſtructive, ſaid the Lady; I have taken notice of two or three already, as you have whirled the Earth and Moon round the Sun. But pray for what other End do you thus turn it now?

Only to bring it to ſhew you the *Autumnal Equinox*, ſaid I, Madam! and then you will plainly ſee the Reaſon of the *Equality of Days* and *Nights* all over the Earth, when ſhe is in that Poſition.

O! Sir, ſaid ſhe, I thank you; this explains the Figure you drew for me before, by which alone I could not get ſo diſtinct and ſo clear an Idea of the Earth's two Motions, as thus ſhewn me. But *now* I ſee, that as the Earth turns round her *Axis*, juſt one Half of the Equator and all Parallels to it, will be on the Light, and the other Half in the Dark; and therefore the Days and Nights muſt be every where equal: For I ſee the *Horizon of the Earth's*

Diſk now lies parallel to the Plane of the *Solſtitial Colure.*

Excellently well remembred and expreſſed, ſaid I, Madam. Your Ladyſhip, I ſee, hath ſtudied hard ſince I ſaw you laſt in the Country, and we are now ſure of you for an Aſtronomer.

I do not know that, ſaid ſhe, it is probable I may never take Pains enough to go into the *Calculatory Part*; but I think every one ſhould be deſirous of knowing the Reaſon of theſe common Things we are now upon, and which happen to us every Year. But pray, Sir, go on, and ſtop when the Earth comes to be in *Cancer.*

It is now got thither, ſaid I, Madam; and you will obſerve that the *Horizon of the Diſk*, or that Plane which divides the Earth's two Hemiſpheres, the *Enlightened* from the *Dark* one, is now no longer *parallel* to, but lies at *right Angles* to the *Plane* of the great *Solſtitial Colure:* The Earth being now in *Cancer*, the Sun will appear to be in *Capricorn*; and conſequently it will be our *Winter Solſtice.* And you ſee plainly, that as I keep turning the Earth round it's Axis either Way, the entire Northern frigid Zone, or all Parts of the Earth lying within the Artic Circle, are in the dark Hemiſphere; as you ſee by this little bit of Wafer, which I ſtick upon the Circumference of that Circle.

Your Ladyſhip will obſerve alſo, that now I remove that *Bit of Wafer*, and place it in the Circumference of that Circle which exhibits the *Path of the Vertex of London*, how much *Longer*, in a diurnal Revolution of the Earth, *that* will be in the *Dark*, than in the *Light*: Juſt ſuch is the Diſproportion of our Days to our Nights at that Time; ſcarce a third Part.

I ſee this Thing, ſaid ſhe, exceeding plain; and alſo that the Inhabitants of our *North Pole*, if any ſuch there are, have not ſeen the Sun ſince the 12th of *September*.

Nor, cannot again, ſaid I Madam, till the Vernal Equinox; for all this ſix Months they muſt be condemned to perpetual Darkneſs: Only the Sun never being above 23½ Degrees below their Horizon, and the moſt of the Time not above 10 or 12; the Sun, by his ſhining on their Atmoſphere, reflects them ſuch Light as we have about half an Hour after Sun-ſet: Alſo they have Moon-Light for Half of the Time, ſo that both theſe added together, it is not ſo very dark with thoſe at either Pole, during the Abſence of the Sun, as at firſt you imagined. But pray obſerve, Madam, that as I move the Earth along in it's Orbit, till it comes thither, how the *Nights ſhorten*, and the *Days lengthen*, by Degrees till they come then to an Equality again on the 10th of *March*; when our Earth being in the firſt of *Libra*, the Sun muſt appear to be in the firſt Degree of *Aries*. And now the *Earth's Axis*, which you ſee always keeps parallel to itſelf, will come again to be in the Plane of the *Horizon of the Diſk*, and conſequently the Equator, and all it's *Parallel Paths* will be *biſſected* by that *Horizon* in every Diurnal Revolution of the Earth; or there will be an *univerſal Equinox* all over the Globe.

This, ſaid the Lady, is indeed ſeeing into the very Bottom of the Matter, and underſtanding it from it's Cauſes and Original. But pray, Sir, turn about your

Handle again; and get me our dear Northern Pole out of the Dark, as I ſee it will ſoon be, and then I hope it will enjoy the Benefit of ſix Months cheering Day, as it hath had a melancholy half Year's Darkneſs.

That it will, Madam, ſaid I; and now you will obſerve with Pleaſure, how the *Days encreaſe*, and the *Nights decreaſe*, as the Earth moves on towards *Capricorn*, where now I will ſtop it; while you obſerve that all the *Polar Circle* is got into the enlightned Hemiſphere; as alſo above two Parts in three of the *Path of London* (*b L m f*) in *Fig.* V. and therefore now our Days are at the *Longeſt*, that is our *Summer Solſtice*, or *Midſummer*.

Yes, ſaid ſhe, I ſee it, and underſtand it perfectly well: But I ſee withal, that our Days, now at their greateſt Extent, are going to ſhorten again, which I will bear as long as I can, that is, till you wheel the Earth about again into *Aries*: But then, if you pleaſe, we will leave off, having attended upon the Earth in one entire Revolution round the Sun; and moſt demonſtratively and delightfully ſeen, how thereby all the

Phænomena of the different Seaſons of the Year, and the Varieties and Viciſſitudes of Night and Day are ſolved and accounted for.

Pray, when you ſee Mr. *Rowley*, thank him from me, for this moſt noble and intellectual Entertainment.

CLAUDIANI Epigr. XIII.

In Sphæram Archimedis.

Jupiter in parvo cum cerneret æthera vitro
Riſit, & ad ſuperos talia dicta dedit:
Hucciné mortalis progreſſa potentia curæ?
Jam meus in fragili luditur orbe labor!
Jura poli, rerumque fidem, legeſque deorum
Ecce Syracuſius tranſtulit arte ſenex!

Incluſus variis famulatur ſpiritus aſtris,
Et vivum cirtis motibus urget opus!
Percurrit proprium mentitus ſignifer annum
Et ſimulati novo Cynthia menſe redit!

Jamque ſuum volvens audax induſtria mundum
Gaudet, & humana ſidera mente regit,
Quid falſo inſomtem tonitrue Salmonea[*] *miror.*
Æmula naturæ parva reperta manus.

Thus imitated and applied to Mr. Rowley's
ORRERY.

When lately *Jove* the *ORRERY* ſurvey'd.
He ſmiling thus to Gods in Council ſaid;
How ſhall we ſtint preſuming Mortals Pow'r?
The *Siracuſian* Sage did, once before,
The heavenly Motions ſhew in Spheres of Glaſs,
And the Erratic Orbs and Stars expreſs:
But his Machine by one fixt Pow'r and Weight,
Mov'd, and was govern'd, as we are, by Fate,
While the bold *Rowley* in his Orrery
Keeps his firſt Pow'r, juſt like his Genius, free:

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[*] *Salmoneus* King of *Elis*, by driving a Chariot over a Braſs-Bridge, dared to imitate Thunder; for which *Jove* ſlew him with a Thunderbolt; for thus *Virgil*, *Æn.* VI. ſpeaks of him.

Vidi & crudeles dantem Salmonea pœnas,
Dum flammas Jovis, & ſonitus imitatur Olympi.

He knows the ſecret Springs; and can impart
Laws to the Whole, and to each ſingle Part;
His daring Hand, or brings or hinders Fate,
Makes *Mercury* fly, or *Saturn* walk in State.
He makes the Earth thro' *ſilver Zodiac* run
Juſtly obſequious to the *Golden Sun*:
While the bright Moon ſhining with borrow'd Light,
Marks out the Months, and rules the Sable Night.
And all obedient to his ſole Command,
Turn round their Axis, as he turns his Hand:
Their *Phaſes* and their *Aſpects* all diſplay,
And at his Beck, exhibit Night or Day:
He makes Eclipſes, as he will appear,
For any paſt, preſent, or future Year;
Shews their true Cauſe, and roots out vulgar Fear.
Guiltleſs *Salmoneus* at your Suit I ſlew,
Shall I, to pleaſe you, take off *Rowley* too?
O! no! all cry'd; the glorious Artiſt ſpare;
Tranſplant him hither, and make him a Star.

This famous Sphere of *Archimedes* is mentioned by *Cicero* and by *Ovid*; and the *former* ſaith, that it ſhewed the Motion of the Sun, Moon, and Planets. *Pliny* tells us, that *Atlas* and *Anaximander* both made ſuch a Sphere; as *Diogenes Laertius* ſaith *Muſæus* alſo did. *Sextus Epiricus* ſaith it was made of Wood; and *Cælius Rhodiginus*, that it was of Braſs.

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